

July 24, 1961

# Aviation Week

*and Space Technology*

**More Pictures  
Of New Russian  
Military Aircraft**

75 Cents

A McGraw-Hill Publication

Soviet Yakovlev Blinder  
Interceptor-Bomber



ANOTHER ASPECT OF THE MARQUARDT VISION

## ELECTRIC PROPULSION

Realized space travel, free from gravitation in a natural vacuum, presents new and difficult problems in the propulsion and control of space vehicles. Electric propulsion promises a potential and economical means of accomplishing space exploration programs.

The three main types of electric engines, while varying in performance specifications, share common advantages over chemical engines. The electrothermal, electromagnetic, and electrostatic engines offer specific impulses greater than 1,800 seconds and thrust durations measured in weeks to months. As a result, electric propulsion systems have the capacity to deliver much longer payloads over longer distances than will conventional rockets. Power for these electric engines can be drawn either from nuclear energy sources built into the vehicle or from solar collection.

The Marquardt Corporation—long a leader in the field of propulsion—is intensively engaged in a variety of unique electric propulsion projects. An example is the electrothermal area in the Boostjet. Here the hydrogen propellant passes over an electrically heated resistance element prior to its

expansion in a deflagrant nozzle. The Boostjet provides capabilities: long life, direct coupling to the power supply, high efficiency, a simple starting cycle, and troublelessness.

The Marquardt Corporation's efforts in the space propulsion and control fields serve to typify yet another aspect of the Marquardt Mission.

Creative engineers and scientists are needed. All qualified applicants will receive consideration regardless of race, creed, color, or national origin.

**THE Marquardt CORPORATION**  
CORPORATE OFFICES, VAN NUYS, CALIFORNIA

## CAPABILITY is spelled

**s-e-r-v-i-c-e**

Aerospace components—even those with the highest order of reliability—must be backed by an organization capable of providing all the requirements of a complete service program.



At Eastern Air Lines Miami base Howard Crothers of Vickers checks maintenance of DC-8 pump at service test unit with L. Wachol, Foreman, and J. Schwartz, lead mechanic.

Proposed modifications of units for improved service and reduced maintenance is discussed with EAL engineers Merly and Young.

Fast service to customers on overhauled units is insured by large stocks of retasking group assemblies.



Proper overhaul and part inspection instructions are observed by A. Weigand, general foreman of assembly overhaul for Eastern Air Lines.

**VICKERS** offers the skills, experience and/or material for all areas essential service areas: 1. field service, 2. product improvement, 3. technical publications, 4. spare parts, 5. repair and overhaul, 6. training for customers and Vickers personnel, and 7. product support tools and test equipment.

Availability of skills and services is depth is the heart of the Vickers program. For example—technical representation not only provides the unmatched skills and experience needed to assist military and civilian maintenance personnel but also gather performance and statistical information for improvement in existing products or for new designs.

Highly skilled, broadly experienced technical representatives like Howard Crothers, a 19-year Vickers service veteran, are available wherever needed throughout the free world. Equally important, they can draw on the talents of a large, experienced organization when specialized skills are needed. More details on the many facets of Vickers service are available in Bulletins 6900-A and A-5229. Write, wire or call today for your copies.



**AERO HYDRAULICS DIVISION  
VICKERS INCORPORATED**

DETROIT 32, MICHIGAN  
SAN FRANCISCO, CALIFORNIA

Div. of  
**SHERY HARRIS CORPORATION**

**PROGRAMMED POWER IN FLUID TRANSFER •  
POWER TRANSMISSION • ENERGY CONVERSION**

# Beyond All Others...



## Here's Why Silastic Is Used In Man's Probes Into Space!

By going faster and further into space, the X-15 adds to our rapidly expanding knowledge about the domain of man and materials surviving the trip out—and back. That's why only proven materials are selected. One of those is Silastic® LS, the Dow Corning Garsilicone rubber that resists oils, fuels and solvents.

Engineers of Rocket Motors Division of Thiokol Chemical Corporation specified an accumulator diaphragm of Silastic LS for the X-15's XLR-99 engine. The accumulator provides oil at a constant pressure to the fuel oil pumps. Gaseous nitrogen under pressure is the source of stored energy, and is separated from fuel by Helicor™ oil by the Silastic LS.

Here are diaphragm requirements the designers established as essential: An elastomer flexible from -50 to 250 F; Silastic LS maintains its flexibility from -30 to 300 F; compatible with the fuel oil at low and elevated temperatures (Silastic LS has little swell or change in durometer readings after immersion in many hot oils, fuels and some hydraulic fluids); will not exsorbinate fuel oil (Silastic LS has no plasticizers or additives which can exsorbinate by leaching).

Silastic LS... the only elastomer to meet all these requirements... helps the X-15 as it banks on the door to outer space.

Shown below is the XLR-99 rocket engine. The fuel oil accumulator is the light weight type... made possible by the diaphragm of Silastic LS... instead of the heavy, bulky piston type. Parts of Silastic are engineered to meet your specific needs by your rubber lubricant.



Write Dept. 3419 for your copy of our new Aviation Industry Handbook



**Dow Corning CORPORATION**  
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D.C.

## AVIATION CALENDAR

- Aug. 13—South Western Research Meeting Aerospace Associated Society Meeting Officer Board, San Francisco, Calif.
- Aug. 13-14-15—Annual 11th National Science Conference, Wichita, Kan.
- Aug. 24—Session Meeting on Aerospace Applications for High-Speed Fluids Test Methods Aerospace Society for Young Materials, Santa Fe, N.M., Pacific 7th side, Calif.
- Aug. 14—North Central States' Airport Managers Conference, Miami, Fla.
- Aug. 14—Guidance and Navigation Conference Aerospace Research Society Stanford University, Palo Alto, Calif.
- Aug. 15-17—Dragage Engineering Conference University of Michigan, Ann Arbor
- Aug. 16-18—International Symposium Conference Aerospace Research Society, Cambridge, Mass.
- Aug. 19-20—Institute of the Aerospace Sciences (AIAA) Aviation Meeting, New York, N.Y., Calif. (abstracts)
- Aug. 20-21—Western Electronic Show and Convention, San Francisco, San Francisco
- Aug. 21-23—Fourth Annual Air Development Symposium Aerospace Research Society, Northbrook, Illinois
- Aug. 24-26—South Annual National Symposium, DCA Club of America, Alta Hotel, Wichita, Kan.
- Aug. 26-28—West Coast Conference of Aircraft Mechanics, University of Washington, Seattle, Wash.
- Aug. 28-Sept. 1—International Heat Transfer Conference, University of Colorado, (Continued on page 6)

## AVIATION WEEK and Space Technology

July 30, 1967  
Vol. 12, No. 4

...the most advanced power conversion system now being designed and manufactured by ITT for the Project Ranger moon probe built for NASA by Jet Propulsion Laboratory. The overall system provides 27 different DC and AC outputs at several discrete voltages, currents and frequencies... using ground, solar cell and battery power sources.

ITT and McDonnell Deak combine their power and electronics capabilities to provide the best in spaceflight electronics systems.



## TOTAL POWER SOLUTIONS...FROM ITT

### THE MOST ADVANCED POWER CONVERSION JOB YET ATTEMPTED

Shown here is a simplified block diagram of the unique integrated power conversion system now being designed and manufactured by ITT for the Project Ranger moon probe built for NASA by Jet Propulsion Laboratory. The overall system provides 27 different DC and AC outputs at several discrete voltages, currents and frequencies... using ground, solar cell and battery power sources.

Total power capability such as 900—400 for conversion, inversion, modulation and control—is readily available from ITT to solve your toughest power problems. Contact your ITT representative, or write for File AN-1360-3

ITT and McDonnell Deak combine their power and electronics capabilities to provide the best in spaceflight electronics systems.



**Industrial Products Division**  
1100000000 Telephone 400 Telephone 400  
2000000000 Telephone 400 Telephone 400  
2000000000 Telephone 400 Telephone 400

Electronic power conversion • Instruments • Aircraft electrical distribution



# KIDDE PRESSURE VESSELS: MORE SHAPES, MORE SIZES, MORE EXPERIENCE!

For more than 60 years, Kidde engineers have designed and made thousands of pressure vessels in a multitude of shapes, materials, capacities and strengths. Today, with pressure vessels an important part of missile or rocket programs, it's only logical that engineers rely on Kidde experience.

Kidde pressure vessels range from discharge rate to 2500 cubic inches capacity, from a life of 10 years to 100,000 cycles; pressures up to 30,000 psi. Kidde pressure vessels are made in steel, aluminum, titanium—welded or drawn—were wound—minimum weight for application. Configurations are practically limitless—including cylindrical, spherical, conical, torus. Many are available on an off-the-shelf basis!

In addition to solving current problems in pressure vessel applications, Kidde engineers are also hard at work advancing today's technology to solve tomorrow's problems. So, if pressure vessels have you stumped, why not call on Kidde for the answer most people don't.



## Kidde Aero-Space Division

Walter Kidde & Company, Inc., 717 Main St., Rockville, N. Y. 10966

See Engineering Office: Atlanta • Boston • Buffalo • Cincinnati • Dallas • Denver • Detroit • El Paso • Fort Worth • Houston • Los Angeles • Miami • New York • Philadelphia • Portland • St. Louis • St. Paul • San Francisco • Seattle • Tampa • Wichita • Wichita Falls • Wichita, Kansas • Wichita, Nebraska

## AVIATION CALENDAR

(Continued from page 5)

- Builder Cuts:**  
**Aug. 18-Sept. 1**—Second Annual Businessmen General Electric Advanced Electronic Control Council Transactions, N. Y.  
**Aug. 18-Sept. 4**—Third Annual Symposium Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Sheraton Hotel, Los Angeles.  
**Sept. 4-10-1961** Flying Display and Exhibit, Society of British Aircraft Constructors, Farnborough, England.  
**Sept. 4-14**—English Anglo-American Astronautical Conference, Royal Astronomical Society and Institute of the Astronomical Sciences, London, England. Wilton Triangle Memorial Lecture, Sept. 12.  
**Sept. 5-10**—National Symposium on Space, Personnel and Technology, Institute of Radio Engineers, University of New Mexico, Albuquerque, N. M.  
**Sept. 7-14**—Air Meeting, Western States Society/The California Institute of Science of California, Berkeley, Calif.  
**Sept. 30-11**—National Convention, National Science Area, Washington, D. C.  
**Sept. 13-14**—International Operations and Maintenance Symposium, Aerosol Corp., Middlesex, N. J.  
**Sept. 13-14-1961** Annual Meeting, Aeronautical Council, American Society of Naval Engineers, Washington, D. C.  
**Sept. 14-15**—North Atlantic Joint Service Engineering Management Conference, Institute of Radio Engineers, Hotel New York, New York, N. Y.  
**Sept. 15-17**—Special Convention, National Association of State Aviation Officials, Miami Beach, Fla.  
**Sept. 18-23**—Industrial Electronics Symposium, Institute of Radio Engineers, Bedford Hotel, Boston, Mass.  
**Sept. 20-24**—National Convention and Aero-Space Symposium, Air Force Association, Philadelphia, Pa.  
**Sept. 20-21**—General Convention, National Business Aircraft Association, Wake Hotel, Tulsa, Okla.  
**Sept. 20-23**—Series of Experimental Test Flight, Fifth Annual Symposium (including a forum on the Supermarket Transport and Launch Report), North Hill Hotel, Beverly Hills, Calif.  
**Oct. 2-6**—Second National Communications Symposium, Institute of Radio Engineers, Hotel Ohio, Ohio, N. Y.  
**Oct. 2-7-12**—International Astronautical Congress, Washington, D. C.  
**Oct. 3-5**—National Airport Conference, University of Oklahoma, Norman, Okla.  
**Oct. 9-11**—National Aerospace Engineering & Manufacturing Meeting, Society of Automotive Engineers, Ambassador Hotel, Los Angeles, Calif.  
**Oct. 9-13**—Aerospace Rocket Society's 1961 Annual Meeting & Space Flight Report to the National Congress, New York, N. Y.  
**Oct. 24-25**—Federation Aeronautique Internationale 1961 General Congress, Hotel Grandhotel, Rio de Janeiro, Brazil.  
**Oct. 25-26**—Joint Meeting, Canadian Astronautical Society/Institute of the Aeronautical Sciences, Ottawa, Canada.  
**Oct. 27-27**—1961 Annual General Meeting International Air Transport Association, Australia.

## SEGMENTED

### Solid Rockets for Space

Aerojet-General's segmentation principle promises reliable off-the-shelf boosters for space missions. Standardized, transportable segments are stacked and clustered to produce any desired thrust—tailoring the power of the solid motor to meet the requirements of the payload.

Segmentation is a proven principle. After several successful segmented flights beginning as early as February, 1960, Aerojet successfully test-fired the world's largest solid rocket under an Air Force contract on June 3, 1960—a 30-ton plant producing a half million pounds of thrust. The motor was made of three segments joined together just before firing.

Aerojet's segmented solid rockets provide a rapid, economical response to the challenge of placing large payloads in space.

### SOLID ROCKET PLANT

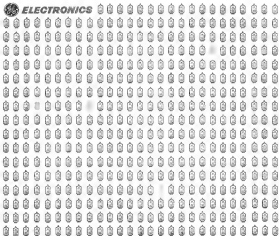
**Aerojet-General**  
CORPORATION  
Bakersfield, California



Engineers identify—evaluate outstanding opportunities for Aerojet



**ELECTRONICS**



## G-E Five-Star tubes prove 99.11% reliable in 10,000 hour life test

Four hundred and fifty type 6589 Five-Star tubes were subjected to a DC life test to study the effects of heater voltage, heater-cathode potential and plate dissipation on vacuum tube life and reliability. After 10,000 hours of operation, failure rates were such that no statistical significance could be ascribed to them. Of the 450 tubes tested, only four failures occurred: two at 2800 hours, one at 2800 hours, one at 8900 hours—despite the fact that the test parameters were purposely made severe enough to produce early failure. For example, in test lot number six, 50 type 6589 Five-Star tubes were tested

under severe conditions (elevated heater voltage: 6.0 volts, over 100 watts negative heater-cathode potential, 3.40 watts per plate dissipation). There were no failures at 18,000 hours. Test data supplied upon request.

In life tests such as this, and in everyday performance, G-E Five-Star tubes prove their reliability in critical applications: airborne navigation and communications, industrial control, two-way communications, broadcast. Five-Star are not tubes selected from standard receiving types. They are specially designed, specially manufactured to cope with particular electrical requirements

and withstand severe environmental conditions such as shock and vibration. Where you can't afford to compromise performance and reliability, order Five-Star tubes from your General Electric tube distributor, Distributor Sales, General Electric Company, Room 7141A, Owensboro, Kentucky.

**VACUUM TUBE • SEMICONDUCTOR  
PARTS DEPT. • BIRMINGHAM**

*Progress Is Our Most Important Product*

**GENERAL ELECTRIC**

## BIG ACCELEROMETER PERFORMANCE IN A SUBMINIATURE PACKAGE!

The LA-500 Series is the smallest non-pneumatic linear accelerometer available today featuring a variable reluctance pickup and essentially constant damping over the temperature range of  $-65^{\circ}\text{F}$  to  $+250^{\circ}\text{F}$ . It is the smallest instrument of its type that can measure acceleration levels up to 50 G.

Reliability through overall simplicity was the primary goal of the LA-500 design. An example is the seismic mass support which eliminates sleeve bearings and their inherent friction. The result of this basic design objective is an accelerometer which can be relied upon

to operate instantaneously and for long periods, even after months of storage.

The combination of miniaturization, ruggedness, and high performance makes this instrument ideally suited for advanced aircraft and missile applications where space and weight considerations are critical.

Write for Technical Bulletin BN-SLA5-1 to Honeywell-Honeywell, Inc., Division, Dept. 2, 1600 Soldiers Field Road, Room 35, Menlo Park, California 94025. Military Products Group Office Sales and Service offices in all principal cities of the world.



Internal view of LA-500,  
magnified 1.5 times

### PERFORMANCE DATA

- SIZE: 1 inch in diameter by less than 1 1/2 inches high (nominal)
- WEIGHT: Approximately 2 grams
- DAMPING: 0.01 sec. constant  $\pm 0.05$
- RANGE: up to 50 G
- PICKUP: Variable Reluctance design provides infinite resolution and high signal-to-noise ratio
- LOW FREQUENCY: EXCELLENT RESOLUTION ( $10^{-3}$  G)
- EXCELLENT LINEARITY:  $\pm 0.05\%$  to full scale,  $\pm 0.1\%$  to full scale
- LOW HYSTERESIS: Less than 0.05% full scale
- LINEAR ACCELERATION: 10 G's or 2 times full scale, whichever is greater
- LINEAR VIBRATION: 15 G's to 2 Hz to low G levels, 30 G's to 2 Hz to high G units

- Small Size
- Simple Construction
- Reliable
- Self-Test Available



Semiconductor accelerometer LA-500,  
shown in size

**Honeywell**

**Military Products Group**

Consult Honeywell for your specific linear accelerometer requirements



## New 10-place jet trainer

The Lockheed C-140 is a compact jet transport. It flies fast and high like jet fighters and interceptors — at just a fraction of their operating and maintenance cost. It can train an entire class of students for hours at a time, rather than one man for a few minutes. And students learn the fine art of operating radar and weapon control systems in tactical and strategic strength in a favorable environment, because the C-140's entire cabin is pressurized and air-conditioned. Students see the real thing on their radarscreens and instruments. The Lockheed C-140 also can stretch defense dollars when used for navigational aids, checking, canopy evacuation, weapons system flight testing, and for high priority cargo and passengers.

**LOCKHEED GEORGIA**



Lockheed Aircraft Corporation, Georgia Division, Marietta, Georgia.



## aircraft belong in the air



Airplanes earn their keep by flying! Tied up in ground inspection, they only bite deep into your profit margin. Just as with military aircraft, the requirements of rigid, thorough air-frame inspection must be met . . . and that's where Anso Supercat Montepak® comes in.

Each Montepak contains one sheet of Anso Supercat® "A" or "B" X-ray film. (Both yield excellent definition. The only difference is in speed for thick or thin parts.) Montepak tapes directly to the aircraft surface, conforming to the curvature of skin, airfoils and structural members. No duckwork loading . . . no holdups . . . no scratches, dirt or dust. Complicated in-

spection procedures are accomplished in minutes with ease and accuracy.

Anso Supercat Montepak is available in all standard sizes, 100 to the entire. For full information, see your Anso representative, or write ANSCO, A Division of General Aniline & Film Corporation, Binghamton, N. Y.





## LIONEL: Muscles for Missiles

Forming and machining the ultra-tough materials needed in missile manufacture requires muscle...well-developed power and know-how...to precisely bend and shape and expand and finish parts which ultimately become stronger than the machines that produced them. — In this respect we feel that the Lionel organization is especially capable. For materials which resist conventional fabricating methods, we've built our own machines...our own machines and equipment, our own tools, devices, and techniques...all capable of processing obstinate alloys to fine tolerances at high speeds on a routine production basis. — Lionel-designed machines such as the "IMPRES" (Internal Mandrel Pressure Roll Extrusion Shaper) provide high-speed hydroforming of nose cones with superior dimensional accuracy. — In its entirety, The Lionel Corporation presents a vast capabilities complex, each division highly experienced in the design, development, and construction of advanced high quality hardware. Our engineers, physicists and chemists, equipped with modern, efficient laboratory and production facilities, afford a logical and worthy source for the dependable fulfillment of contractual commitments—from components through systems.

We welcome your further inquiry...and suggest that you request a copy of our new capabilities brochure, "LIONEL: A New Force."



**THE LIONEL CORPORATION** Dept. SP-50, Hoffman Plaza, Hillside, N. J.



## Command Reliability

### New Sperry SP-50 Flight Control System

An automatic flight control system offering 200 to 300 percent increase in reliability—with unmatched accuracy and performance—that's the new Sperry SP-50, selected over heavy competition for the forthcoming Boeing 727.

Selection of the SP-50 for the short-to-medium range 727—a jet transport which demands the utmost in reliability for everyday operations in and out of trell airports—emphasizes the fact that the SP-50 solves the most pressing problems of aircraft-transportation today. It is compatible with the fully automatic landing systems of the future. It is designed for routine ILS operations with automatic holdovers for landings under very low ceiling-visibility conditions; it features channelized design, separating automatic control equipment for all axes of flight to facilitate maintenance, and it provides dual yaw dampers, with provisions for "bushings" all functions if desired.

These and other design and performance advantages in the new SP-50 spell superior command reliability today... assure readiness to meet tomorrow's demands. Superior support of this new system is the field, meeting Air Transport Association requirements, also is being "designed in" by Sperry.



SPERRY PHOENIX COMPANY, DIVISION OF SPERRY RAND CORPORATION, PHOENIX, ARIZONA

# population -



Even in the most remote areas, wings aloft are guided on their way by AeroCom's new medium range N.D. Beacon Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendance...even where the total population is zero.

**NOW — FCC type accepted — single or dual automatic — for carrier powers of 10, 12, 15, 20, 25, 50 and 100 watts.**



## **AEROCOM'S** Dual Automatic Package-Type Radio Beacon

For completely unattended service. This N.D. Beacon (illustrated) consists of two 300 watt (or 50 watt) transmitters with 2 layers, automatic transfer and automatic timer. (Power needed 110 or 220 volt 30/60 cycles, 400 V.A. for 50 watt, 675 V.A. for 100 watt.)

Frequency range 300-500 kcs. available with either crystal or self excited oscillator coil. High level plate modulation of final amplifier is used, giving 97% tone modulation. Microphone P-T switch automatic time, permitting voice operation.

The "standby" transmitter is selected when the carrier or modulation level of main transmitter drops 3 db or more, in case of failure to transmit the identification signal or if carrier frequency changes 5 kcs. or more. Audible indication in monitoring receiver tells which transmitter is in operation.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs.

Also available in 400 watt, 5 K.W. and 9 K.W. Models, 200-415 kcs.



3090 S. W. 37th AVENUE • MIAMI 33, FLORIDA



## **TEXTRON ACHIEVES** **ROCKET BELT FOR THE U.S. ARMY**

Unique feats may be possible for the U.S. infantry man of the future...leaping barriers...jumping streams...getting ashore from invasion craft. Now! With a rocket belt developed for the U.S. Army by Bell Aerosystems, a Textron company. An experimental model demonstrated at the Pentagon has completed more than thirty successful flights, carrying a man to heights of 20 feet and distances of 360 feet at speeds up to 20 mph. The thrust is provided by a two-jet hydrogen peroxide propulsion system,

mounted on a fiberglass frame belted to the operator. Offering a promise of increased mobility for tomorrow's soldier, the Bell rocket belt is another in a series of significant achievements from Textron—a group of growing companies with products that lead the way in their fields. ■ Company 24% of total sales volume, Defense 22%, Industrial 20%, Textile 17%, Automotive 17%.

**textron**

PROVIDENCE, RHODE ISLAND





## your map in a **UNIVERSE** of AIRCRAFT PUMPS

That new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, pouring on panels, are high performance gear pumps made to the measure of the most demanding airframe, missile, spacecraft, and support equipment.

Many of these units are the product of newly made, more precise, dual components that can be turned into the precise configuration you need. Custom designed pumps are also available.

All have as common these classic Eastern hydraulic pump characteristics:

**SMALL, SILENT** Eastern gear pumps are the smallest, lightest made. Airframe servo system pump shown delivers 1.5 gpm @ 2500 psi — measures only 1 1/2" x 1 1/2" x 2 1/2", weighs 9 oz.

**WIDE PERFORMANCE RANGE:** pumps available have three rated displacements from 0.16 to 1.33 cu. in. per revolution — flow from 0.075 to 9.6 gpm, pressures from 0 to 2000 psi, at speeds to 24,000 rpm. Weights with motor range from 1.3 to 8.5 lbs.

**UNAFFECTED BY EXTREME ENVIRONMENTS:** rugged, reliable Eastern units take loads to 50° in shade — range of temperature differentials to meet MIL specs.

### Other Eastern products:

- hydraulic motors
- servocams, solenoids, actuators and spools
- pressurization/differential pumps
- multi-displacement couplings
- electronic tube cooling units

## **EASTERN INDUSTRIES INCORPORATED**

100 SKIFF STREET • HAMDEN 14, CONNECTICUT  
WEST GRAFT BRIDGE • 4901 SPENCER ST. • TORRANCE, CALIF.



## revolutionary new power cutter from UTICA

**First Tool of Its Kind.** The Utica UA-100 is an air operated, drop-in head power cutter for high volume production. Designed for the electronic industry, the UA-100 cuts wires off assembly time.

... induces operator fatigue to a minimum. Snap cuts as fast as the operating lever can be triggered.

This new product of our Utica Drop Forge & Tool Division symbolizes Kelsey-Hayes capabilities in diversified areas of industry. Long experience and broad scope in research, development and production developed in contemporary products that bear the stamp of the future.

For further information on the UA-100 Power Cutter, write The Utica Hand Tool Division, Kelsey-Hayes Company, Utica 4, N. Y.

## **KELSEY HAYES COMPANY**

Automotive, Aerospace and Agriculture Tools  
Hand Tools for Industry and Home

**INTERNATIONAL PLANTS:** Japan, Korea, Mexico, Canada, Brazil, Argentina, Chile, India, Italy, Spain, Germany, France, Belgium, Russia, Sweden and Finland, Canada, Canada.





The Defense National Communications Control Center by Philco

## FINGER-TIP CONTROL FOR GLOBAL COMMUNICATIONS

Keeping U. S. Armed Forces communications traffic flowing rapidly and efficiently is an enormous task. The Defense National Communications Control Center was designed, fabricated and installed by Philco for the Defense Communications Agency to provide the means to monitor and control this gigantic traffic load.

The Control Center is constantly supplied with the current world-wide status information by stations operated by the Army, Navy and

Air Force. This information is processed by the Center, where the status of the entire world-wide system is displayed in order that control can be exercised. When a breakdown or overload occurs anywhere in the system, communications are rerouted and vital information is quickly re-routed through alternate channels.

Another major contribution by Philco for National Defense.

Government and Industrial Group, Philadelphia 44, Pennsylvania

**PHILCO**  
*Philco for Quality the World Over*

Communications and Weapons Division • Communications to Systems Division  
 Computer Division • Micro Electronics Division • Weapons Development Laboratories

July 24, 1967

# Aviation Week and Space Technology

Vol. 75, No. 4  
 Publisher: AEP and AEC

INTERNATIONAL EDITION: New York 201-300 W. 42nd St., 10th Floor, New York, N.Y. 10018-0001. Telephone: 212-850-1000. Telex: 212-850-1000. Cable: 212-850-1000. Post Office Box 999, New York, N.Y. 10108-0999. Second-class postage paid at New York, N.Y., and at additional mailing offices. Postmaster: Send address changes in U.S.A. to Aviation Week, Inc., 201-300 W. 42nd St., New York, N.Y. 10018-0001. Outside U.S.A. to Aviation Week, Inc., 201-300 W. 42nd St., New York, N.Y. 10018-0001.

**EDITORIAL** — Robert W. Smith, Jr.  
**EDITOR** — Robert W. Smith, Jr.  
**MANAGING EDITOR** — William G. Smith  
**TECHNICAL EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Jack Anderson

**MANAGING EDITOR** — Jack Clark  
**ASSISTANT EDITOR** — Irving Stone  
**EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Robert W. Smith, Jr.

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

**EDITOR** — Fred A. Anderson  
**ASSISTANT EDITOR** — Fred A. Anderson  
**EDITORIAL ASSISTANT** — Fred A. Anderson

### Photos of Soviet Aircraft Show New Missiles 25-31

► Soviet MiG 21 fighter carries missile similar to USAF's Skybolt. Bombers are armed with air-to-surface missiles like Hovey's Sup.

### Senate Moves Toward Mars Bomber Funds 32

► Lobby asks \$448 million total for \$70, \$325 million for \$35. President to reveal his views this week.

### Compulsion Forces Frank Endorsement Fair 40

► Even to fill growing steel capacity, producers rate cut, may push cost business to more dominant position.

### SPACE TECHNOLOGY

Communications Satellite System 33  
 Soviet MiG 21 Shows New Design 34  
 Soviet Satellite Talks 35  
 Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### MANAGEMENT

Senate Moves Toward Mars Bomber 32  
 Soviet MiG 21 Shows New Design 34  
 Soviet Satellite Talks 35  
 Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### AVIONICS

Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### EQUIPMENT

Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### ORGANIZATION

Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### CONVERT

Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

### NOTICE TO READERS

Soyuz-7 Launches From Pacific to East Coast 36  
 Russian Traffic—May 37  
 Soyuz-7 38  
 Soyuz-7 39  
 Soyuz-7 40  
 Soyuz-7 41  
 Soyuz-7 42  
 Soyuz-7 43  
 Soyuz-7 44  
 Soyuz-7 45  
 Soyuz-7 46  
 Soyuz-7 47  
 Soyuz-7 48  
 Soyuz-7 49  
 Soyuz-7 50  
 Soyuz-7 51  
 Soyuz-7 52  
 Soyuz-7 53  
 Soyuz-7 54  
 Soyuz-7 55  
 Soyuz-7 56  
 Soyuz-7 57  
 Soyuz-7 58  
 Soyuz-7 59  
 Soyuz-7 60  
 Soyuz-7 61  
 Soyuz-7 62  
 Soyuz-7 63  
 Soyuz-7 64  
 Soyuz-7 65  
 Soyuz-7 66  
 Soyuz-7 67  
 Soyuz-7 68  
 Soyuz-7 69  
 Soyuz-7 70  
 Soyuz-7 71  
 Soyuz-7 72  
 Soyuz-7 73  
 Soyuz-7 74  
 Soyuz-7 75  
 Soyuz-7 76  
 Soyuz-7 77  
 Soyuz-7 78  
 Soyuz-7 79  
 Soyuz-7 80  
 Soyuz-7 81  
 Soyuz-7 82  
 Soyuz-7 83  
 Soyuz-7 84  
 Soyuz-7 85  
 Soyuz-7 86  
 Soyuz-7 87  
 Soyuz-7 88  
 Soyuz-7 89  
 Soyuz-7 90  
 Soyuz-7 91  
 Soyuz-7 92  
 Soyuz-7 93  
 Soyuz-7 94  
 Soyuz-7 95  
 Soyuz-7 96  
 Soyuz-7 97  
 Soyuz-7 98  
 Soyuz-7 99  
 Soyuz-7 100

50,000 copies of this year printed

## Another Surprise Coming?

The Tushino air show of a few weeks ago provided a sharp surprise to the American people, who had been misled by their leaders as recent years to believe that the Soviet Union had abandoned advanced development of manned aircraft and was concentrating solely on ballistic missiles and space weapons. These leaders in turn have been badly informed by their intelligence services, not because of the working-level input but because of top-level intelligence control decisions to ignore evidence that did not suit their preconceived idea of what should be happening.

Although Cohen and Tushino revealed some of the Soviet misperceptions in the use of our critical intelligence gathering machinery, the full impact of the sad bureaucratic bungling has yet to be told, probably because it is well shielded under the official stamp of secrecy.

However much of a shock it is to the American people to discover that the Red Air Force, which was supposed to be fading into obsolescence, had suddenly blossomed out with a full array of new generation aircraft across the whole technical spectrum from supersonic bombers and long range interceptors to small transport and helicopters are wonder if an even greater shock may yet be in the offing. We wonder if the full response has an nuclear testing that the United States has been operating under for the past three years may not be leading toward the disruption of our once commanding lead in nuclear weapons development. Will we wake up another Monday morning soon and find that the Soviets have been secretly testing new generations of nuclear weapons when this conflict is possible with their operational capability?

This possibility has also been raised by John McCone, a California Republican who has had a long and distinguished career in government both in the Defense Department and as chairman of the Atomic Energy Commission. This is what he led to on his point speech:

"Nuclear weapons development by underground and outer space testing will give to either the United States or the Soviet Union a number of weapons, both large and small, more powerful, more versatile and more useful in modern warfare than those now in vogue. The Soviets can proceed with these developments behind their walls of secrecy without detection, as no present scientific means of discovering their action exist or can be created without inspection posts within their country and the right for on-site inspection.

"The Soviet's adamant refusal to accept a reasonable plan for policing a test ban agreement by refusing appropriate means for inspection is reason to believe they are developing new and improved weapons in clandestine testing. Thus they can develop a great nuclear arsenal, and, yet, respecting a self imposed moratorium, will take second place.

"Efforts to reach agreement have now failed because

of Soviet unreasonable positions. Our security is at stake. We must secure weapons testing as essential to the safety of our country and the free world. Soviet prohibitions that they are not interested in testing appear indefensible as similar statements were frequently made regarding manned aircraft, but now they display several new military planes secretly developed.

"Will they soon display advanced nuclear weapons?" The initial surprise toward a nuclear test has come from the world-wide public hysteria over nuclear fallout suddenly promoted by the Soviet Union. Admittedly, the strident anxiety expressed by the American Energy Commission on the basic facts of fallout contributed enormously to the success of the Soviet hysteria promotion and is another key example of how secrecy hurts much more than it can possibly help.

Now, however, the techniques of underground testing have been deployed to the point where considerable development work can be done by this method without any atmospheric fallout. Development of nuclear testing in outer space is certainly feasible, although considerable work on adequate instrumentation must be done before it will be practical. Here too, atmospheric fallout is eliminated.

The truly important lesson to be learned from the Tushino air show of 1961 and the field trip to be avoided is continuing a unilateral nuclear test ban is that in dealing with the Soviets, we must cover all technical possibilities across the board if we are to avoid the disastrous consequences of strategic surprise. Then, it is no use, short of total nuclear security in dealing with a determined and formidable as adversary as the USSR. The Soviet Union is developing every phase of its military power, from the massing of land troops equipped with mobile missiles that can be, par excellence, on command catapult launching vehicles, air borne tanks and tanks to the supersonic bombers and fighters of the air force, also armed with formidable missiles to the ballistic missile rocket forces and finally into the military applications of outer space.

This concern can no longer afford to swallow the complete arsenal that our military forces are in studies to cope with any manner the Soviets may present. In all but a few cases our state of military preparedness is extremely low.

If we are to convince either our friends or foes that we mean what we say about Berlin or any of the other issues that are certain to arise along the US-USSR interface we had better stop talking about how wonderful our "wonder weapons" are and begin to actually do something about plugging the great gaps that exist in our current military posture. At the same time, we must continue adequate preparation for the future development of all of the remarkable frontier possibilities in gap-filling technologies of our have now reduce to the realm of probability.

—Robert Hotz



POLARIS second-stage, rocket motor case being produced at B.F. Goodrich

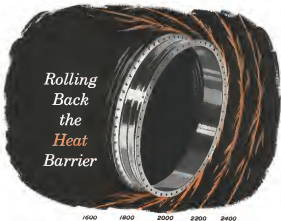
## B.F. GOODRICH OFFERS COMPLETE CAPABILITY IN FILAMENT-WOUND ROCKET MOTOR CASES

- BFG the ingredients for successful production of filament-wound plastic/composite glass fiber structures are
- An active BFG development program for resin systems, backed by years of research in rubber and plastics chemistry
- A pilot plant program for producing glass fibers with superior properties
- Years of experience in unidirectional filament construction
- A machine design group which engineers the production equipment for the two techniques
- Facilities for producing the complete structure, including end-line heat, in one location

This complete capability can help you in designing and producing light, strong, heat resistant structures...for rocket motor cases, missiles, and pressure vessels. For details describing the filament winding method, write B.F. Goodrich Aviation Products, a division of The B.F. Goodrich Company, Dept. AP-78 Akron, Ohio.

**B.F. Goodrich** aviation products





Rolling  
Back  
the  
Heat  
Barrier

1600 1800 2000 2200 2400



Newest turbine case resembles a shape before and rings made of Haynes alloy X

Address inquiries to Haynes Steel's Company,  
375 Park Avenue, New York 17, N.Y.

The surging power of modern 20,000-pound thrust jet engines is being harnessed effectively by critical parts made of Haynes high-temperature alloys. Turbine and stator are typical of the hot spots in which these alloys serve. Here, in the form of turbine seal rings, they contain the hot combustion gases as they pass through the various turbine stages. In these, and in other parts too, such as afterburner liners, flame holders, shrouds, and investment-cast turbine blades and stator vanes, Haynes alloys are resisting the punishing effects of long hours at high temperature. In fact, one of the Air Force's latest 1800-MPH jets uses six different HAYNES alloys in vital parts where heat and stress would weaken and fatigue other materials. Whether investment-cast, sand-cast, rolled, wrought, vacuum-cast, or air melted, there's a Haynes high-temperature alloy to meet your needs.

**HAYNES**  
ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation  
Kokomo, Indiana

UNION  
CARBIDE

\*Haynes "Monobloc" and "Open Carbide" are registered trade marks of Union Carbide Corporation.

## Washington Roundup

### Soviet Fighter Exports

Soviet Russia now is exporting its latest generation of operational supersonic fighters to Soviet satellite air forces and is pushing first-generation supersonic fighters and jet bombers into countries with communist leanings.

East Germany, Hungary and Poland now have the Mikoyan MiG-21, delta-wing Fubled fighters in their air defense units, while limited numbers of versions of this supersonic, outstripping even the MIG 19 T-1000 are now the mainstay of the Egyptian and Iraqi fighter forces. Fighters also have been shipped to Cuba. Russia has exported 12 late-model MIG 17 F-1000 fighters to Morocco and Bulgaria, jet-propelled fighters to Indonesia.

### Zeus Production

Intensive Soviet effort in microelectronic missile defenses, coupled with U.S. progress in missile defense techniques, now result in early production of the Nike Zeus missile system. Defense Department is expected to recommend to President Kennedy that the Fiscal 1967 budget now being prepared include money for initial production without waiting for results of testing tests in the Pacific.

The decision is based on recent advances in missile detection, discrimination and data processing—plus growing evidence of an all-out Soviet effort in the missile defense field. One important aspect of this massive Administration effort is the geographic advantage that would fall to the first country to demonstrate capability to kill an incoming missile in flight.

Decision that the director of Defense research and engineering's office has to approve initiation of research studies has reduced the flow of Study Requirements to a trickle—not, apparently, because proposed studies are being turned down but because the reviewing process is so slow.

### Space Center Scramble

Schedule for National Aeronautics and Space Administration's new \$50-million manned space flight center has been joined by the President's home state, Massachusetts. Lincoln, Graham and Lonsdale have been asked to lead the battle and Virginia has been fighting hard to keep the nucleus of the manned flight group right where it is—in Virginia's Langley Field.

Because he is chairman of the subcommittee which considers NASA's money requests each year, Rep. Albert Thomas of Texas has had a powerful edge in the fight but then it seems that his birth is so poor that his influence on key NASA defense and atomic energy committees will come to be a disadvantage. Recently, he issued a statement for Texas congressional wing his efforts has found him sound despite mounting private trouble, and unless I get best I'll be running 15 years from now.

Defense Secretary Robert McNamara, who has leaned toward serious consideration in the past, has about concluded that the way to keep our service from running away with the bid is to plan them out against the other and thus has altered his ideas about the desirability of having only one service.

### Snop Acceleration

A major acceleration of development work on Space Nuclear Auxiliary Power (Snop) reactors is planned by the Atomic Energy Commission. Enriched will be on a nuclear power reactor rather than the ordinary type, the reactor type now in the spring of 1967.

There will include power for transmission of data from soft lunar landing packages, for short-lived and flying space navigation lights, and for sustained remote weather stations.

Confusion over the appointment of Angus G. Maxwell Taylor as military adviser to the White House about a possible conflict from President Kennedy at his press conference last week, but it was truly a full explanation. "Now when General Taylor is appointed it is regarded as a demonstration of the responsibility of the Joint Chiefs [of Staff] which is not," the President said. "But it may also be a result of a conversation between the Joint Chiefs and Secretary [of Defense] McNamara."

### More Patent Hearings

Hearings designed to work out a federal policy on rights to inventions made under government contracts are scheduled to resume late next month. Chairman Charles D. Hays, Director of the House Science and Subcommittee on Patents, Copyrights, and Trademarks is heading up an overall government policy. But he says he will not be involved, rather than the current set of rapid and slow-moving and is to be a South point policy is slowly but surely working.

State Department and foreign service employees crossing the North Atlantic by jet aircraft will be required to finish common air travel class, beginning Aug. 15. Expected saving is \$100,000 per year.

Sen. Charles McNamara's hearings before the subcommittee on national policy mechanisms will bring two former field experts back to town—William J. McNeil, who was Pentagon comptroller under Douglas MacArthur and Eisenhower, and Alexander H. Stern, who was President Eisenhower's last director of the Bureau of the Budget.

—Washington Staff



Bomb Mark 2 heavy bomber carries a ballistic type cruise missile to USAF Shashid along under its belly (note arrow) during Tushino air show. Missile is rocket propelled, about 65 ft. long and is partially housed in the fuselage belly with the remainder of the missile and its associated ducts tail fin visible. Missile range is estimated at over 500 miles and at supersonic speeds.

## New Air-to-Surface, Air-to-Air Missile Types Are

Formation of four long-range bomber flies over Tushino equipped with large weapons, safeguarded as bomber carries along under four specially modified bellies. These arms, formerly plucked to house bombbodies, but been modified to hold ordnance for missile guidance. Even every operational squadron identification number on nose with No. 40 on lead plane and No. 37 on bottom plane.



Formation of Tupolev bomber twin jet bomber shows carrying an air-to-air missile resembling USAF Round Dog design with jet engine along under fuselage body. Maximum effective range of this jet propelled missile is estimated at about 250 miles. No. 30 fighter over has been equipped to home guidance radar. Bombers operational since 1955, formerly used as conventional bomb delivery system.

## Identified on Soviet Bombers, Fighters at Tushino

Closeup of the missile-carrying Bombers shows design details of the Round Dog type missile and the arm under nose of the twin-jet bomber. Formation of missile-carrying Bombers flew at Tushino, indicating the missile-bomber combination is in operational service.





Two different versions of Yakovlev Flashlight seen outside the Model B (above) all-weather interceptor equipped with large side-entrance intake on the nose. Two jet engines with afterburners mounted under the swept wings and large intake ducts mounted. Profile, lower version of Flashlight B shows more changes over the prototype first seen at Tushino in 1976. A black version, Flashlight C, (below) appeared in magazine illustrations indicating the 1995 Yakovlev prototype went into production with modifications such as addition of ventral fin, breaching valve in belly and supersonic optical engine intake. Both versions of Flashlight shown are in Mach 3.2 class.



Two different Mach 2-plus prototypes (right and left) of new generation Soviet interceptors seen at Tushino. Both planes are apparently delta designs and feature a large single intake engine and delta wings but carry two different types of air-to-air missiles. Fighter at right has unusual joint scheme with tail boom along leading edge of delta wing and around mid fuselage.



Formation of Mikoyan Fiddler Mach 2 delta-winged fighters is shown armed with a Schukovskiy-type air-to-air missile mounted under each wing. Note large ventral fin and rolled-in intake in nose. Fiddler has an operational record with Soviet air force as well as the satellite air forces of Poland, Hungary and East Germany.

## Soviet Fighters Show Varied Armaments



Both designs shown above differ from the new Mikoyan design shown here (AWF July 18, p. 24 and July 17, p. 26) which carries another type missile and has two large intakes with two tailpipes and a rocket engine fixed in between them at the tail.



Two types of operational interceptors are shown over Tushino. Fiddler (left) carries three Schukovskiy-type missiles one under the belly and each wing. Sukhoi-designed Fitter (right) carries rocket-propelled missiles under each wing and belly fuel tank.



Boeing Stear II twinjet underwing engines and tail-mounted horizontal stabilizer show contrast in design approach with that of the Martin P5M. The P's engine mounting makes for a deeper hull and less fuselage clearance than the P5M but permits the lower hull mounting with fewer structural problems. Engines appear to be mounted close aboard and the fuselage struts from the nose to the intake and the complex bow shape (below) may be designed to guard against water ingestion. Extension from fuselage under the tail (below) may be retractable magnetic surface detection gear or possibly a door for nose lying in position of other stores.



Mil Flying Crane, in flight at Tushino lifting a freight car over board, is derived from the Mi-4 but has a larger rotor hub and longer blades suited for its mission. Cargo velocity has been increased with larger and more numerous rotors and fuselage appears longer than the Mi-4. Canards extend from sides just ahead of the front landing gear; a probable telescoping compartment for a crane is possible at viewing by wings landing. The power rotor forward or aft removal of loads.



Yakovlev designed by Pavel Sukhoi (above) constructed more than 1000 in 10, others modernized but built in Soviet-Gang pods. Yakovlev first flew in prototype in 1978. Tushino air show and has been in production and operational service for several years as a day fighter. New Kamov turbine-powered helicopter is shown (upper right) with novel rotors a large rear rotor and two large, no-rotor rotors suspended from the landing gear on either side of the fuselage. Smaller piston-powered Stear Ka-15 (lower left) is shown flying formation with the larger piston-powered model. Kamov also designed the Sikorsky configuration shown at Tushino. Part of large Yakovlev fighter formation (bottom) shows away from Tushino during fly-by in squadron-sized groups. Delta wing planform and nozzle treatment are visible in silhouette. Vented for air is stable.







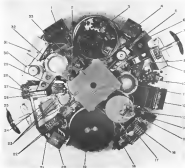






### Tiras III Scans West Coast

Could it be another California satellite in the picture taken about 12:45 p.m. July 16 on 34th orbit of NASA's Tiras III observation satellite. Photo is of the coast of an old stream. Dark area at lower right is the California coast around Eureka. The picture was received from the satellite at San Nicolas Island and transmitted to Pacific Marine Corps.



Tiras III payload compartment: 1-telocator camera receiver package; 2-telocator beam splitter prism (receiver); 3-type recorder (case removed); 4-type recorder antenna package; 5-telocator camera; 6-type recorder power converter; 7-camera directional indicator; 8-telocator camera control package; 9-type recorder power converter; 10-light measuring equipment control panel and (below) antenna receiver; 11-electronic clock; 12-scanning subcarrier; 13-light measuring equipment receiver (and type recorder package); 14-telocator detector; 15-non-scanning indicator; 16-voltage regulator; 17-battery protection panel and (below) timer (below); 18-telocator transmitter (below); 19-telocator transmitter power converter; 20-type recorder power converter; 21-type recorder power converter; 22-type recorder power converter; 23-type recorder power converter; 24-type recorder power converter; 25-type recorder power converter; 26-type recorder power converter; 27-type recorder power converter; 28-type recorder power converter; 29-type recorder power converter; 30-type recorder power converter; 31-type recorder power converter; 32-type recorder power converter; 33-type recorder power converter.

## GAO Charges USAF Space Parts Waste

Washington—General Accounting Office has charged Air Force with wasteful millions of dollars in the purchase of replacement parts which it did not know it already had in inventory.

The charge, contained in a report to Congress, was based on an investigation of 512 of the 90,000 replacement equipment items in the USAF inventory.

Those items, included in USAF's "Unit Anticipation List" consist of equipment—such as aircraft ground handling equipment, test equipment, communications, and ground support—on which a long service life, does not have a clearly defined period of use, and is generally not incorporated in a replacement cycle.

The report estimated that GAO saved 5338 million of the total of \$2.5 billion in total expenditures on replacement equipment. GAO found that \$114 million worth of the items involved was not included in the inventory. The parts went to competing additional equipment and "not otherwise" or "unclassified" for.

The report estimated that "over 567 million worth of replacement equipment purchased in fiscal year 1960 could have been avoided and approximately for another \$208 million, as which replacement was deferred principally for lack of funds." It said that the inventory had the "the Force maintained adequate control over the equipment purchased and received in the supply chain."

Conceding that it did not estimate a savings, the report said that "the Force was not adequately supported (USAF) in the comparison of equipment low-budget program" of the Air Force has notified GAO of necessary corrective actions.

Those include the establishment of such base as a Central Equipment Management Office.

Conceding that the steps taken and planned by USAF are largely preventive, GAO withheld judgment as to whether they "will successfully overcome the serious and widespread problems observed by us."

As an example, GAO pointed to a 1960 report that 141 V-12 sets failed at approximately 514 million, were not presented for replacement data. Of those, 81 sets right at the Sacramento Air National Area.

The Sacramento Air Material Area base assigned a fiscal 1960 purchase replacement of 316 sets. Facilities of 101 generator sets not delivered and per contract was ordered for 165 sets at an estimated cost of approximately \$2.4 million.

## Soviet Gravity Research

Washington—Effects of Soviet space tests in international publications are so intense and widespread that they warrant the closest national watchfulness," according to a 109-page analysis of Russian research literature compiled for the House of Congress Science and Technology Committee.

The report is available through Commerce Department's Office of Technical Services here. It was introduced in a study of scientific work by Soviet professor of mathematics K. P. Stetsko, published in 1954 and 1957, about the possible applications of gravity. Stetsko was a member of the USSR Academy of Sciences space commission and a professor at the Moscow Higher Technical School.

Stetsko Soviet physicist here said, "large his theories, and they demonstrate the current status of Soviet scientific position." "With a serious of uncertainty and limitation," the report said, "it is a significant advance in the understanding and possible control of gravity in long objects both in the outer world and in the lower area—and could afford satisfactorily potentials in its domains," the study said.

## First Ranger to Seek Earth's Hydrogen Trail

Washington—First Ranger spacecraft, because of its high speed, will seek long trail of hydrogen in the outer space. It is scheduled to be launched this month from Cape Canaveral. As one of eight scientific experiments that are on the mission, the Ranger will attempt to determine whether the earth has a comet-like trail of hydrogen gas.

Ranger can travel more than half a million miles from earth before returning to burn in the atmosphere, or it may enter a solar orbit. For the first time in the outer space program, the Atlas Agena B launch vehicle will be used. The Agency says that during the 15 days after leaving earth, the payload into its earth orbit and continue in this "parking" orbit until it reaches the optimum point for venturing to begin the long trip into deep space. This technique is not important to the first test but will be used in later tests.

Ranger one of the most complex payloads the U.S. has built is being developed by NASA's Jet Propulsion Laboratory. It is hexagonal in shape, about 15 ft in diameter at the base and 11 ft long. With solar panels extended, it is 17 ft by 13 ft. It weighs 6750 lb, weighs 144 lb in scientific experiments, 247 lb in electronics, 238 lb in a stove and night and the payload weight 10 lb.

Ranger will act as attitude stabilizer, too, to store and later use as an attitude and 10 wings per gram for control a high-gain antenna, as some advanced communication system, calibration of solar cells in space and an experiment in chemical reaction forces of metal against metal in space.

The hydrogen experiment is aimed at learning what will be involved in the operation of satellites, with moving parts. It is aimed to check, in outer space, so that various. The experiment consists of a meteoroid shield with disks of different metals on it. Flying against the disks are ions of various different material. Stetsko, mentioned in the study, has proposed to check the disk after five months between each 30 different combinations of metals.

## Fuel Cell Test Vehicle Contract Won by GE

Washington—General Electric will build test vehicle for 30-day. Three tests of a 30-cell fuel cell battery in a 100 m test.

General Electric has awarded a \$542,000 contract to GE Mobile and Space Vehicle Department to construct the test vehicle. The test vehicle will have a volume of about 6 in ft and carry approximately 1000 lb of fuel cell and electronic and telemetry equipment all packed in the test cell battery.

The test cell battery is to be developed and built by the GE Aircraft Division, Turbine Department will consist of 30 individual cells. Output will be, as a result, 1000 watts. Hydrogen and oxygen will be the fuel for the test cell. The test cell will be the first test of the test cell. The test cell will be the first test of the test cell. The test cell will be the first test of the test cell.

The experimental program is expected to be completed by the end of the year. The test cell will be the first test of the test cell. The test cell will be the first test of the test cell.

## News Digest

House and Senate last week agreed on a compromise bill authorizing the full \$1,754,100,000 sought by President Kennedy for the National Aeronautics and Space Administration, increasing the annual fee for research and development from \$100 million to \$150 million. The compromise bill also as the amount to provide 500 million for the total propulsion development and 507 million for research programs.

Bill defense action not assigned last week in Defense Secretary Robert S. McNamara's Office of Civil

Defense. McNamara will become the Office of 11 weeks. Planning to plan contractors of state and local governments, national disaster relief, defense mobilization and materials production.

RCA Astro-Electronics Division will build three ground test and four light test simulators for the company for National Aeronautics and Space Administration. The test simulators will be used to test the flight test vehicle and a NASA mission fielded engine.

French government has indicated its willingness to finance 30 of a reported 400 additional Soviet C-130 military transport. The company wanted 100 additional to transport personnel, the helicopter force of 214. French production program is for 150 (AW July 17, p. 52).

North American T-39 flew from Midland to New York in 9 hr 39 min elapsed time last week, closing an official long-distance speed record by one day. The T-39 was flight scheduled stops at the Army Air Corps and North American and being, speed is 413 mph. A service at New York's Idlewild airport presented certificates for an official record.

Frank Pace, Jr., General Services chairman, has been appointed to the Foreign Intelligence Advisory Board to replace Gen. Maxwell Taylor, who will leave office within a year.

Eastern Air Line is exploring possibilities of purchasing one of two test planes in conjunction with its air shuttle service. The test plane is the Cape Cod plane, which is used in the 1000 ft landing of an aircraft, scheduled to be completed by the end of the year. The test plane is the Cape Cod plane, which is used in the 1000 ft landing of an aircraft, scheduled to be completed by the end of the year.

Ground test vehicle VHC-3B helicopter is scheduled during the year. The test vehicle will be the first test of the test vehicle. The test vehicle will be the first test of the test vehicle. The test vehicle will be the first test of the test vehicle.

Made only winning satellite ground station will be built at Kallak, England under terms of a U.S. British agreement. The satellite station will be used to test the flight test vehicle and a NASA mission fielded engine. The satellite station will be used to test the flight test vehicle and a NASA mission fielded engine.

41





Left: Shell engineers test flame-sprayer at the Aeroshell Turbine Fuel Equipment Laboratory—first in the U.S. Right: New Lockheed jetliner aircraft. Shell sold its own billion gallons of aviation fuel last year.



STRENGTH-BUILDING WITH A BATTERED FLAME-SPRAYER

## Shell Research reports on 5 advances in fuels and lubricants and discloses how they improve aircraft performance

**1. First non-ink additive oil for piston engine aircraft.** Aeroshell® QM W is the first fully compounded additive oil ever approved by every major piston engine manufacturer in the U.S. Aeroshell QM W is the first piston engine oil that does not form harmful varnish with deposits.

It helps keep engines cleaner, extends piston life and overhauls, can even lengthen engine life.

**2. Shell grease lubricates X-15 as it sets world's speed record.** Twenty-five greases were tested for use on the X-15 rocket plane. Only one—Aeroshell Grease 34—passed all tests and was commercially available.

Today, Aeroshell Grease 34 guards 25 land-based planes on the X-15 as it sets new speed records for manned aircraft.

Aeroshell Grease 34 is also recommended for commercial and private aircraft.

**3. Full-scale gas turbine research lab.** Shell Research built and opened one of the petroleum industry's earliest laboratories designed for testing gas-turbine performance in full-scale turbine engine combustion systems. That paid off in 1953 when the first turbine retro-

duced to three aircraft. Shell is steadily rich the fuel.

Shell has the most extensive aviation fuel distribution network in the nation for general aviation and sold over a billion gallons of aviation fuel last year.

Today, Shell is the leading supplier of commercial aviation fuel in the U.S.

**4. First turbine fuel equipment lab assures maximum cleanliness.** Shell was up the first U.S. laboratory in the industry to study carbide fuel cleanliness for purposes to assure Shell's ability to deliver consistently clean fuel to your airplane.

As a result, today's Shell turbine fuel is of outstanding quality. You can buy it with absolute confidence.

Whenever plane you fly, wherever you fly, in Shell's experience in aircraft fuels and lubricants assure you of top performance.

**5. Shell and fuels of the future.** Shell has developed a special hydrocarbon fuel for Mach 3 flight. But the credit that will use a three jet to be perfected. When they are, Shell will be ready.

Shell rocket fuel—LH2/H2—C—is today powering the first-stage boosters of many of today's space shuttles.

### Special note to airport dealers

Shell offers independent dealers a complete range of assistance.

Shell's technical representatives are backed up with the solid experience and technical know-how that has made Shell the nation's top supplier of commercial aviation fuels.

Shell's advanced product and operation with pilot assure that you will stay profitably ahead with a Shell dealership.

Contact your Shell District Office for details. Or write: Shell Oil Company, 30 West 50th St., New York 20, N.Y.



**A BULLETIN FROM SHELL**  
—where 1,001 scientists are helping to provide better products for industry



### Japan Air Lines Receives First Convair 880-M

First Convair 880-M transport of the plane order has been delivered to Japan Air Lines by General Electric's Western Group. First has been named Shiro in Claret. Second will be named 880-M to be delivered to JAL before the end of the month. First two transports will join the carrier's fleet in May, 1962. Interior of the 98 passenger plane was decorated in a Japanese motif. The General Electric CP66-18 powered aircraft will be used by JAL on a Tokyo/Wong Kong/Bangkok Singapore route.

## Northwest Pegs Profit to Cost Controls

By Glenn Garrison

New York—Tight cost controls helped Northwest Airlines share a net profit of \$44 million for the first six months of this year compared with a loss of \$224,000 for the same period of last year, despite a drop in gross operating income because of strikes which curtailed operations during part of 1961.

President Donald W. Noyes told members of the New York Society of Security Analysts here that Northwest's operating losses for the 1961 period totaled \$4,971,000, with operating expense of \$42,471,000, but an operating profit of \$34 million. Comparable figures for the first half of 1960 were \$41,973,000 operating expense, \$61,419,000 operating expense, \$554,000 operating profit.

"The airline industry is a series of red tape, budget controls," Noyes said, with monthly budget reviews. Northwest's total operating costs per available seat mile according to figures presented by Noyes to the analysts, the second year has a long list of items in the cost breakdown in domestic service—American, TWA, United, Capital and Delta. A results comparison of 12 months ending August shows Northwest with the lowest available seat mile costs of all U.S. and foreign flag carriers in international service.

At the end of 1960, according to Noyes' figures, Northwest's domestic seat mile cost was about 16.5 cents. Highest in the world was Capital Airlines at about 24 cents. These statistics only cost line Capital got into trouble. Noyes told the analysts.

Continental Airlines was not included in the comparison, and Noyes admitted that Continental was "doing a fine job in cost control" and probably was showing results as good as Northwest or better.

As a result of its generally long-haul route structure, Northwest has one of the highest average dollar ticket sales in the business, he added. The airline route to Miami helped to reduce a seasonal imbalance. Northwest did not sell on the Miami route in the 1959-60 season but was started by studies in the last Florida season. Another favorable factor is less competition on international routes than first had to transatlantic operations.

Northwest serves some small cities on its domestic routes, and this position in serving them differs from that of some other airlines. Noyes said, Northwest has not tried to discontinue such services because of fairly slow, growing enough long-haul traffic to make the service worth while, he added.

In addition to labor troubles, Northwest was hampered in 1960 by the El Centro accident and resulting speed restrictions. Direct operating costs of the transport increased 20%, Noyes said. There was also the problem of public air transportation. But the airlines were back to normal speed Apr. 1 on Northwest's routes. Load factors are good now and there is little or no resistance on the part of the public. Direct operating costs now range about \$1.25 per mile, compatible with the DC-8, and further reduction is expected in the future.

Direct operating costs of the airline's DC-8s are \$2.46 per mile. Noyes said. This is high and reflects the strike period when the emphasis was on the ground, getting no money but picking up dependent costs. Scheduled flights

from the DC-8s cost mostly not to be 30 to 35 cents daily average. Boeing 720B utilization will be about 10 to 20 per cent. The El Centro accident was a slight loss, but the DC-8 utilization is slightly less than 8 to 9.

Regarding the 720B, Noyes said he expects full string of 57,000 new seats, with New York West Coast flight reprogramming 5,000 to two with the 720B then with a straight run.

Asked of the effects on Northwest of the United Capital merger, Noyes said United is a truck company and "two months I heard Capital put the war then over." But Northwest should compete adequately with United, he said. On the Seattle-New York route, Northwest carried 67% of the passengers in 1957, 49.5% and 1959 when it competed with United, Noyes said.

Northwest's El Centro is not intended to compete with United's and Capital. Noyes said. The El Centro will serve short haul routes where the Capital could not make money. Where the Capital and "100 airports," the 720B will outstrip the Capital's cost of the work.

Regarding the future traffic growth of the industry, Noyes predicted a rate of 5-12% during the next five years. In 1960, long-haul utilization will probably reach 100% for travel. In 1961, Northwest's own growth rate was about 14% a year from 1954 through 1959, which he doubts will be repeated at about 10% in the next five years in route slack.

Noyes said he expects further mergers in the industry within the next five or six years. However, Northwest at present has no merger or acquisition plan under consideration, he said.

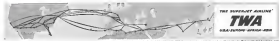


*Movies in flight...another TWA first*

First-run movies are now being shown on Superjets. The choicest films from Hollywood and Europe are featured on selected daily flights between New York and California, projected on a special wide screen in the First Class section. Featherweight headsets bring

the speed only to those who wish to see the movie. Others are not disturbed. Staring next month, movies will be shown on select TWA overseas flights. This is the latest innovation to make your flight seem even faster and more enjoyable aboard **TWA Superjets**.

The only airline serving 70 U.S. cities and 23 world centers overseas.  
For reservations call your travel agent or TWA.



THE SUPERJET AIRLINE  
**TWA**

### Airline Traffic—May, 1961

	Revenue Passengers	Revenue Passenger Miles (RPM)	Passenger Load Factor %	to 5-Min Turn-Time	Expense Per-Mile	Weight Per-Pass	Total Revenue Per-Mile	Operating Cost
DOMESTIC TRUNKS								
American	459,745	499,999	68.8	3,200,300	1,812,460	18,139,108	18,139,108	273
Boeing	191,902	198,492	58.9	44,419	1,613,495	991,644	19,840,603	68.8
Capital	279,461	116,216	58.1	44,320	200,899	491,444	12,154,099	68.8
Continental	311,444	37,616	46.9	203,877	112,449	279,277	12,154,099	68.8
Balle	19,933	179,499	48.4	168,813	104,200	1,211,294	1,211,294	104.1
Eastern	167,847	283,516	59.1	1,179,516	934,499	2,116,999	1,654,964	118.9
Delta	12,449	66,991	48.1	170,499	22,119	284,499	2,284,964	118.9
Western	142,449	47,499	46.9	112,442	43,119	323,933	3,409,499	118.9
Northwest	142,449	99,499	60.9	100,534	118,516	284,933	3,409,499	118.9
Southwest	289,244	350,449	59.9	1,474,936	659,999	4,871,344	3,409,499	48.8
United	494,243	307,943	58.3	3,279,349	1,042,019	8,219,416	9,709,339	48.8
Western	109,244	41,499	55.4	270,933	107,919	349,277	4,652,739	48.8
INTERNATIONAL								
American	2,717	5,432	76.8	8,654	384	147,191	93,936	106.9
Boeing	7,181	17,733	64.9	72,022	1,021,289	1,743,249	1,743,249	68.9
Continental	97,498	8,893	68.2	3,424	9,479	1,171,249	1,171,249	68.9
Delta	7,181	7,181	68.2	3,424	1,171,249	1,171,249	1,171,249	68.9
Eastern	34,734	36,909	70.3	1,912,119	494,344	3,594,939	3,594,939	21.9
Delta	15,116	5,409	70.3	1,912,119	494,344	3,594,939	3,594,939	21.9
Western	14,918	14,918	60.6	1,499,026	199	719,137	3,594,939	21.9
Northwest	5,074	5,359	50.4	88,099	9,214	149,936	939,936	68.9
Southwest	134,471	317,847	14.3	3,468,333	4,912,932	29,922,984	29,922,984	68.9
United	49,944	112,471	47.7	2,496,309	3,829,232	14,797,434	14,797,434	68.9
United	41,494	49,494	75.4	2,274,934	10,944	1,171,249	1,171,249	68.9
Western	7,044	16,355	70.3	87,459	544,499	9,999,999	9,999,999	68.9
Southwest	134	272	36.9	392	1,194	49,499	49,499	68.9
United	17,116	14,264	68.2	771	3,427	3,427	3,427	68.9
United	88,809	79,848	44.4	1,022,116	1,722,044	19,493,124	19,493,124	68.9
United	11,809	39,213	59.3	960,444	7,169	149,999	4,479,414	68.9
Western	3,472	5,709	46.9	12,144	36,444	36,444	36,444	68.9
LOCAL SERVICE								
Allegiance	71,477	15,719	49.8	23,499	49,009	73,044	8,886,886	68.9
American	33,793	8,462	49.8	7,999	3,999	12,944	40,999	68.9
Continental	29,243	2,791	46.9	14,291	7,499	1,499	1,499	68.9
Frontier	98,969	7,916	49.8	32,138	88,927	48,499	81,024	68.9
Local	33,124	6,291	70.7	11,349	39,499	14,999	40,999	68.9
Western	11,209	11,209	44.9	16,009	22,099	1,199	1,199	68.9
Northwest	61,026	14,023	42.1	48,499	46,319	48,191	1,240,491	68.9
Southwest	99,499	1,944	49.9	2,499	29,499	37,014	48,914	68.9
United	70,929	7,709	49.9	4,954	4,954	4,954	4,954	68.9
United	48,283	9,461	49.9	12,349	12,373	34,491	1,409,799	68.9
Western	33,279	4,663	49.9	26,712	13,447	13,233	40,336	68.9
United	27,043	7,348	49.9	10,814	10,814	48,499	48,499	68.9
West Coast	31,893	7,233	49.9	16,360	9,598	34,943	765,448	68.9
HAWAIIAN ISLES								
Alaska	34,709	5,433	49.9	5,233	8,944	399,499	399,499	68.9
Hawaii	34,709	5,367	49.9	5,233	8,944	399,499	399,499	68.9
CANADIAN ISLES								
American	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Frontier	4,973	14,824	46.8	16,438	26,426	1,731,709	11,446,427	77.3
Frontier	3,273	11,254	50.8	1,092,143	8,406,499	6,999,091	6,999,091	68.9
United	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
DISCOUNT ISLES								
Alaska	31,176	988	49.9	1,343	8,489	149	38,937	37.6
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
New York	63,128	203	31.9	1,464	819	50	34,979	48.8
ALASKA ISLES								
Alaska	9,779	9,779	49.9	4,469	2,345	107,449	1,093,149	46.4
Alaska	3,779	103	46.9	4,473	9,686	70,639	70,639	46.4
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	4,419	996	79.9	1,933	8,610	3,499	44,919	44.9
Alaska	3,212	70	46.9	4,473	9,686	70,639	70,639	46.4
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319	1,319	49.9	1,319	1,319	1,319	1,319	68.9
Alaska	1,319</							

Follow [www.fishbase.org](http://www.fishbase.org)

Copyright © AVIATION WEEK Inc. All rights reserved. No part of this publication may be reproduced without written permission from the publisher.





## Pioneers in mission management



superior flight



superior bombers



space exploration

**MARK III, IV**—powered to progressive projects by the Flight Control Laboratory of the USAF Aeronautical Systems Division. Each objective, a functional application of the mini/microchip concept, finds a wholly integrated control and display system, designed around the capabilities of man and his machine to achieve the ultimate in mission management. And, today, on the threshold of space exploration, the completed ASO/Lear Mark IV product has proven experience and technological know-how to the Air Force—a comprehensive system capability to "teach" all the control/display requirements for mission management to take note.

to the moon  
and on beyond

**LEAR** INSTRUMENT DIVISION • 110 IDINA AVENUE N.W. • GRAND RAPIDS, MICHIGAN

## SHORTLINES

► **Civil Aeronautics Board** Chairman Curtis C. Henderson has recommended that Delta Air Lines' certificate be awarded to allow one-day service between Chicago and St. Louis via either Springfield or Peoria. **B**

► **Continental Airlines** will expand the number of its jet assignments based at Los Angeles International Airport by accommodating the airline's four turbofan Boeing 738s temporarily scheduled for delivery next spring. The 34 jet will have capacity will leave three jet or multi-seat aircraft when completed in March.

► **Elk, Janet L. Giddard** will serve as Federal Aviation Agency's civil air engineer for another two years, heading the Aviation Medicine Service.

► **Eastern Air Lines** will double its overnight, nonstop flight between Boston and New York after Aug. 1. Eastern will fly 16 flight daily in each direction weekdays between 7 a.m. and 10 p.m., compared with eight flights now scheduled.

► **Emery Airlines**, one of two local service carriers doing domestic routes against Civil Aeronautics Board's class schedule rule, has withdrawn its objection and will be paid at the subsidy rate for service restricted to last Jan. 8. Control Airlines is still pending the class rule.

► **Hera Air Lines** will receive one C-47 with military aircraft next January, in March and two in April, 1962. The aircraft will be used on Hawaii, Mexico and Africa routes.

► **International Air Transport Association** has adopted a standard across traffic agreement allowing passengers to transfer airlines traveling between North America and the Orient or Australasia to its one-way and go-by-the-other. Under the agreement, IATA airlines can designate the shipping companies within the Transpacific Passenger Conference with which they will exchange passengers.

► **Military Air Transport Service** has awarded \$2.4 million in contracts for transportation of personnel, passengers and cargo during last July and August to 11 carriers.

► **Viet Galtieri** has been named director of the new United States Travel Service. He was associated with Pan American World Airways 1946-47 and he currently operates travel facilities at the Southern Pines, N.C. area.

## AIRLINE OBSERVER

► **Appointment** of James M. Leach, special assistant to the President, to head the departmental committee with the Airlines on a bilateral air transport agreement is pending. The committee is to ask whether the White House intends to take over all future bilateral negotiations, historically a function of the State Department.

► **Widely** for a move to Scandinavian Airlines System to cut its 14,000 payroll by as much as 2,500 employees as it now management drive for greater operating efficiency. Reduction will be confined principally to the more maintenance and operations base staff, where complete and displacement must because of the continuing requirement that Denmark, Sweden and Norway each participate in SWS activities. In contrast, contracts will be required to eliminate a recent spare part stock, among other changes.

► **Chase Aircraft** is having serious financial troubles. One month after the airline started its inter-Africa service, flight frequency was cut from one a week to one flight once two weeks. Chase's management reportedly was forced to drop important weekend flights to help the carrier meet its monthly payroll. Financial difficulties stem chiefly from the fledgling carrier's excessive equipment and route programs (AW Dec. 32, p. 38). However, the Chase's management reportedly is still willing to conduct substantial losses in order to make Chase Aircraft the dominant carrier of independent Africa.

► **Federal Aviation Agency** has recommended that Congress make several changes, including and other acts of various federal agencies if they are considered on airline reform in interstate commerce. Civil only filed by the Administrator now on FAA's power suggest against such efforts. "The court system could bring a \$1,000 penalty. It's a law that would be considered as a violation by the Administrator N.T. 13410.

► **Record** of lightening flights in a series of striking air disaster in spending American Airlines is conducting Rockwell Ferry II will have flights in a number of other air air routes over weekends. Based plans to offer Boeing 787 lightening flights in Dallas, Mexico, Airlines is operating additional flights with increasing success. The local carrier claims a 100% hit in 30 days, at a \$65 charge, which includes holiday rate and from American Airlines that 90% of its lightening flight continues on first rates.

► **Northeast Airlines** is negotiating with Boeing Co. for three Boeing 738s to replace its old Boeing 707s. Under the plan, Northeast will purchase one additional aircraft and lease two from Boeing.

► **U. S.** has granted loans totaling \$33.5 million through the Development Loan Fund to the government of Ethiopia for various projects. GR has total \$33.2 million will be used to build a 1,000-mile-long road and 22 more airports, and \$1.4 million will be used for maintenance and overhaul equipment and for spare parts for Ethiopian Airlines.

► **Federal Aviation Agency** has purchased an automatic telecommunications system from North American Philips Co. for installation at Anchorage, Alaska. Flight plans, weather information and air traffic control reports will be fed into the system from 65 FAA and other stations and will be switched automatically to the proper receiving station. The system will replace the present process of accepting a punched tape and manually placing it into the proper receptacle.

► **First** complete draft of reports prepared by Project Operations and Project Research Unit, have been distributed to the Defense Department, Bureau of Budget, Civil Aeronautics Board and other agencies for comment. They are to be returned to the Air Force this week, when they will be sent to the White House. Civil Aeronautics Board reaction to the drafts has been reported as highly favorable.

# Kodak's method of recording

# was invented too soon

If photography had been invented during the past five years instead of way back early in the 19th century, people wouldn't be working so hard and spending so much money looking for other ways to accomplish what photography can already accomplish.

The antiquity of photography (slightly bluish some to its virtues. To the extent (right it must be admitted) that this delays its applications in practical problems that it can solve today, the blueness is unfortunate though understandable."

"We ourselves are not blind. We know that there are many ways of producing images. We are investigating a lot of them."



VIRTUE No. 1 is simplicity. Here is a picture of the basic amplifier used in photography.

This amplifier can provide a gain of 10. There is a gain in the bottle. We know him very well.

Some, whose engineers were formed while working out for the coast badge in photography, still think of warming up the glass by rubbing to a hair-dresser and pouring him out of his bottle into a white enamel tray. Therefore, they think of him as always all wet, and this thought discourages them.

We hereby advise them that we can get the glass to work for them for any of a growing number of

techniques in which the wetness hinders down. It's an engineering problem, not a scientific problem. We have a goodly number of engineers who are very competent in the field and are available under suitable arrangements.



This newly announced Virtue Vacuum Processor is a sample of the past work. It does 36 feet per minute. This happens to be the rate at which film runs through a projector. The film speeds about one whole in the position. It emerges processed in standard commercial quality, ready to project. The machine can be stopped for seconds or days and replaced without loss of quality. We are very touchy about processing quality, since we are also the makers by trade and feel a need to keep our faith in photography.

VIRTUE No. 2 is information-packing device. Nothing else is even close to photography in this respect.

Look at this one-inch square. As you will see, if



you whip out your pocket angler, it is composed of the former half-inch dot. You see about 10,000 dots. Into the same area photography could have put the same number of pages of the Encyclopedia Britannica and recovered every character of them.

We can back off a little of the extreme information density for more light-sensitivity and pack only 10 bits of information into a square inch of film. This figure is still hard for non-photographic techniques of data recording to match. Furthermore, it is not just a goal we are working toward. It is available in a film we have actually manufactured by the thousands of feet.



The Kodak Duxon Recorder permits a computer to calculate itself directly to microfilm. Microfilm is the proper medium for accurate detail. Paper need come in, if at all, only at the end of the line for summaries and conclusions. Any part of the supporting data is available for visual reading, if desired. Modifications permit plotting on microfilm from taped data. 2600 points per second, very clear, very linear, very repeatable, very little film from very much tape.

PHOTOGRAPHY
BYRIDE
ELECTRONICS
MECHANICAL
INFRARED

To ask questions about how Kodak can create useful results from the information-packing density, the incomparable sensitivity, and the exceptional simplicity of photography, or for a general look that introduces the interconnected capabilities of the Kodak firm in being in our five fields, write or phone Advanced Marketing Department.



EASTMAN KODAK COMPANY, Apparatus and Optical Division, Rochester 4, N. Y.





"...firm commitment to a new course of action..."

Current achievements by the rocket propulsion industry give reassuring evidence of this nation's ability to seize the initiative in the development of large solid propellant boosters. This has special significance in the light of President Kennedy's appeal "for this nation to take a clearly leading role in space achievement."

Now the industry looks forward to the next significant advance—firing of flight-weight segmented solid propellant rockets of 250,000 and 500,000 pounds thrust at UTC's Development Center.



*Capability backed by four decades of propulsion experience*

**UNITED TECHNOLOGY CORPORATION**

P. O. Box 358, Sunnyvale, California

*A subsidiary of United Aircraft Corporation*

\*Excerpt from the special message delivered by President Kennedy before a joint session of Congress, May 25, 1961.



## ENGINEERING PRECISION GUIDANCE



Inertial guidance systems at General Electric's Ordnance Department represent some of the most exciting and challenging work areas for engineers with ordnance abilities. In addition, the Polaris MK 3 Guidance System demonstrates the Navy's long-range requirements for the kind of precision that Ordnance Department engineers and scientists can deliver.

Here is an area that offers personal opportunity as well as professional challenge. A formal performance review is made annually for each professional employee and top managers reap the benefits of a high promotion ratio. These promotions, together with expanding program activities, have resulted in a number of openings for qualified engineers and scientists. We would welcome the opportunity to provide details.

Present and anticipated growth in plant-related opportunities is there now.

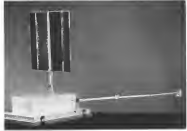
- Guided Missile Systems Engineering
- Digital Computer Engineering
- Electro-Mechanical Engineering
- Guidance and Navigation Engineering
- Electro-Optical Engineering
- Logistics

FOR MORE INFORMATION, write in confidence to:

Dr. W. B. Walker, Manager  
Ordnance Division, Box 84-WO  
Ordnance Department  
General Electric Company  
Pittsfield, Massachusetts

All qualified applicants will be considered for employment without regard to race, creed, color, or national origin.

GENERAL ELECTRIC



STL package shows the proposed arrangement of the folding boom designed to hold an experiment package away from the rest of the instrumentation contained in the satellite.

will be controlled and 15 experiment payloads will be accommodated inside the rectangular body in position to look inward toward earth on external radio links. Six of the payloads will extend completely through the spacecraft and should ultimately be capable of looking both ways. Instrument packages to observe the sun are to be mounted on the outer ends of the two solar cell paddles because the paddles will always be oriented to face the sun. The instrument packages will be unpowered. The only powered component in the observation will be the paddle motor and drive case. Power will be kept in about 15 psi.

The NASA specification requires that each observation accommodation require access to at least two boom-mounted packages at a distance of at least 15 ft from the body of the spacecraft or any other opening. That will be met for experiments which are air-breath, survive in open air, require no service from the other experiment packages in which produce the sort of interference with the other experiments. That is likely to be for other external experiment packages mounted on 4 ft booms but the part of the design is not well defined yet. The 4 ft booms can also carry the three core instrumentation antennas. The packages inside the sun viewing of the large 8 ft boom which the boom will be designed to hold. Interfering booms are not being used because of the possibility of trouble with control.

Mounted in opposite ends of an axis on one end of the rectangular body will be a pair of Global Phase Experiment Packages (GPEP) pre-developed to point sensors or sensors collecting in-

lets into the plane of the orbit. The two package GPEP design was selected to give the vehicle more aerodynamic resistance. The design of the atmosphere near the planned project is good enough to produce a reasonable drag force, which will tend to distort the vehicle if it is unbalanced. STL engineers believe aerodynamic resistance of the GPEP Payloads will cut the gas consumption of the attitude control gas jet reaction motors by a factor of 10.

### Program Cost

The latest contract signed in June and extended most since then provided for a program duration of about 42 months. NASA's original public cost report at the close of the contract at \$15 million but after program effects on the final cost is more apt to be between \$30 million and \$45 million. The data contract still is being negotiated. The spacecraft will be constructed at the new SRI facility in Rosendo Beach, Calif.

Information for the spacecraft attitude control is being a drive from four barometers mounted rigidly on the bottom of the bar-like body and from sun sensors on the solar cell paddles. Control power to orient the spacecraft is provided by three instruments which need a 1.5 volt source within a constant compressed air flow through an eight weeks mounted as a part of 5 ft booms which extend from one end of the body. The booms will have rod at half-hourly points so they can be folded, made the instruments, one drive of the vehicle. The long power will not be used because of the difficulty of protecting leakage of gas

### POLARIS "ON COURSE"—TIME AFTER TIME AFTER TIME

Over 40 Polaris missiles—with completely operating inertial guidance systems designed by Massachusetts Institute of Technology and produced by General Electric—have been flight tested from land, on the sea, and under the sea.

The reportedly precise, reliable performance of this MK 3 Inertial Guidance system now is being applied to the advanced SSK-2 Polaris Inertial Guidance system by M.I.T., G.E. and Raytheon.

This new, advanced guidance system will be much lighter and more accurate, and will help lengthen the striking power of Polaris from 1000 to 2000 miles.

Polaris Inertial Guidance is typical of the many precision products—ammunition, fire control, inertial guidance, launching and handling equipment, force—being produced by General Electric's Ordnance Department.

### ORDNANCE DEPARTMENT

OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

ONE PLASTIC AVENUE, PITTSFIELD, MASSACHUSETTS

RESEARCH, DESIGN AND PRODUCTION OF PRECISION ORDNANCE EQUIPMENT—SINCE 1941

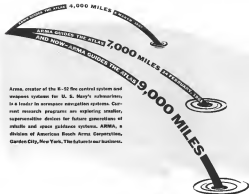
# ARMA guides Air Force ATLAS in first full-range inertial flight

Cape Canaveral July 7, 1961. The Air Force announced the successful flight of an Atlas ICBM guided by the Arma inertial system 5,000 miles into the Indian Ocean.

A giant step in missile and space technology, this important feat of pie-pointing a target nearly half-way around the world demonstrated the phenomenal accuracy and reliability of Arma inertial guidance—America's first inertial guidance system of intercontinental range accuracy. This flight was another achievement of Arma inertial guidance which has performed successfully on

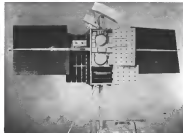
every flight since the initial test in March 1960. Today the Arma system is in full production.

Arma inertial guidance provides our nation's ICBM arsenal with all the advantages inherent in inertial guidance—silent firing, all-weather capability, immunity to outside interference, a minimum of costly ground equipment. Although specified for the Atlas missile, the Arma inertial system is a completely self-contained, self-correcting guidance system adaptable to other aerospace programs and space exploration projects.



Arma, creator of the B-52 guidance system and weapons systems for U. S. Navy's submarines, is a leader in aerospace navigation systems. Current research programs are exploring smaller, superminiature devices for future generations of missile and space guidance systems. ARMA, a division of American Bosch Arma Corporation, Garden City, New York, The Systems and Instruments.

**AMERICAN BOSCH ARMA CORPORATION**



EARLY CONFIGURATION of OGO shows spherical and semispherical equipment modules inside the lock like hulls. Two Global Phase Exposure Packages are at top. The particular instruments shown at the bottom of the assembly has been replaced by a Yag interface

measured again at the hinge. A 15th cupful of sugar at about 1,980 psi is expected to fire the one unit with angle measures. Each attitude control assembly will develop about 0.05 lb. thrust with a flow rate of 0.001 lb. per sec.

#### Monomane Wheels

Cycle attitude disturbances are to be reacted by the monomane wheels. Since the direction of a cycle disturbance is repeatedly reversed, the wheels can hold the vehicle steady without a long-term buildup of velocity by alternating back in one direction then in the opposite one. The wheels will accelerate as an effort to cancel monomane, cumulative disturbances, but eventually will be vitiated when they reach their maximum speed. The gas system will then be fired to disperse attitude, while the wheels are designed.

The monomane wheels cannot be mediated operate only at maximum torque, and have a 180 sec. time constant since a quick sensing active position is not needed. Total angular velocity change is controlled by saving the direction of torque. Pitch and roll monomane wheels are to be identical with a torque of 7 in.-lb. and a maximum angular momentum of 1.5 lb.-sec.

The van wheel will be about twice the size of cables of the other two with a torque of 1.6 in.-lb. and a maximum angular momentum of 6 lb.-sec.

The airplane shape gives the spacecraft the wing-like solar cell paddles under the axis of rotation perfect by S11, engineers a little decrease. The long axis of the rectangular body is the axis about which the spacecraft

rotates. The side and centerline of the two solar paddles is the "roll" axis and the vertical axis of van is perpendicular to the other two.

The first operation of the attitude control system after launch is the "acquisition sequence" during which the spacecraft is maneuvered according to a program while the sensors seek the attitude references. With the paddles parallel to the pitch axis the attitude control system first causes the spacecraft to pitch and yaw until the paddles are perpendicular to the plane of the van. The paddles are rotated in face down, at the van and the van of the spacecraft is rolled until the long axis of the body is pointed at the van. Monomane, but which control is then shifted to the earth-seeking system and another pitch maneuver is executed to let the four horizon sensors on the body find the earth while the paddles rotate to sense along the van. Four laser line sensors are designed for monomane. The fourth is redundant to gas, also built.

Responsibility for roll monomane is also shifted to the earth sensors and the spacecraft is rolled so that the long axis of the body is horizontal with respect to the earth and the van remains in the planes of the long body van and the vertical van. The paddles rotate locked on the van. The monomane is then complete and the earth sensors keep the responsibility for pitch and roll while the van sensor controls van and paddle angle. Sun sensors may be photodiode cells or infrared detectors.

As the gyroscopic observation makes an orbit around the earth, it pitches or

CONSIDER THIS DIFFERENCE ✱ IN

Proportioning  
controls  
for metering  
electrical power



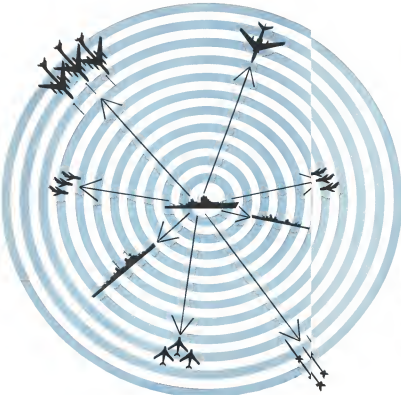
Nowhere will you find a proportioning control system that can compare the performance of the new Barber-Colman automatic proportioning system with these features:

- No leaks—yet accurate ratios meter up to MIL-5-04400
- Power lighting—compensates for lamp and window aging
- Antistatic design prevents unexpected burning out
- Fail safe on element failure
- For windshields, assembly gages, mobile indicators, guidance components and various power metering applications

✱ In addition, Barber-Colman provides a team of experienced engineers to custom engineer a system to meet your specific needs. With personnel, well-ventilated, a great deal of experience, design assistance and service you want on your project? Contact the Barber-Colman engineer nearest your office nearest your location: Boston, Dayton, Fort Worth, Los Angeles, Montreal, New York, Rockford, San Diego, Seattle, Winter Park, Fla., or write:

**BARBER-COLMAN COMPANY**

A subsidiary of the Barber & Colman, Inc.  
Box 1, 1430 Oak St. Detroit, Mich.



# TYPHON...

A Fleet Weapon System  
Development Providing  
Round-the-Clock Protection

Advanced capabilities in system engineering at Westinghouse are bringing a tremendously powerful new shipboard weapon control system into being for the Navy. This vital part of the TYPHON weapon system soon will enter the test phase.

When developed, the TYPHON weapon system will provide the fleet with greatly improved defenses against enemy air-borne weapons, plus longer range attack capabilities. The system is designed to simultaneously handle a larger number of targets than ever before possible.

Heart of the TYPHON system will be an advanced, long-range search, track, and missile guidance radar that will be designed, developed and produced by the Weapons Systems Department of the Westinghouse Baltimore Defense Division, under prime contract to the Bureau of Naval Weapons. The TYPHON program is under

the technical direction of the Applied Physics Laboratory, Johns Hopkins University.

Westinghouse contributions to TYPHON are the result of many years of experience with such basic elements as radar, computers, airborne guidance and control, and search and tracking systems.

TYPHON is another demonstration of how science and systems engineering capability are serving Defense at Westinghouse. Defense Products Group, 1000 Connecticut Ave., N.W., Washington 6, D. C.



A-4001

Westinghouse











# ESAR



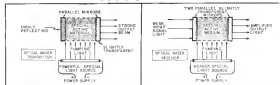
electronically-steerable array radar

An experimental model ESAR radar which demonstrates the fundamental aspects of electronically-steerable array radar is now undergoing test at Bendix Radio. The successful culmination of this experimental effort could provide the basis for a new technology leading to the development of multiple function, electronically steerable array radars capable of searching, tracking, deep space communications and command control. ESAR is part of Project DEFENDER, the program of advanced research to ballistics missile defense directed by the Advanced Research Projects Agency, Department of Defense. The ESAR contract is administered by the Rome Air Development Center at the U.S. Air Force. Organizations working on advanced space concepts are invited to contact Bendix Radio for details, and to use ESAR in operation.

**Bendix Radio Division**  
AIRCRAFT PRODUCTS, BATHURST & NORFOLK



## AVIONICS



**OPTICAL MASER** (left) holds many advantages for space vehicle navigation use with the development of a laser receiver expected soon. The receiver (right) will function with laser transmitter (left) which already has been demonstrated. Receiver transmits transmitter energy that pumping light source a weaker and second mirror is partially transparent to absorb signal from distant transmitter.

## Laser Challenges Radar for Space Use

By Philip J. Klaus

**Williamburg, Va.**—An optical maser (laser) receiver, with unusual characteristics that will make it extremely useful for space vehicle navigation, can be expected as the near future, perhaps within several months, Dr. Cecil B. Ellis of General Dynamics, Inc. predicted here during the recent annual meeting of the Institute of Navigation. The report was co-authored by Don A. Greenwood.

The optical maser receiver, when used with an optical maser transmitter which already has been demonstrated by several companies (AW July 18, 1960 p. 45), should provide a system which can measure distances (range) and velocity with far greater accuracy than is possible with radar.

Equally important for space vehicle use, the optical maser system is expected to be considerably smaller, lighter and less complex than radar, and to consume less electrical power. (For a description of experimental laser radar developed by Hughes Aircraft see AW Feb. 27, p. 41).

In principle, the optical maser (laser) receiver is expected to be possible through the laser transmitter, Ellis said. In the laser transmitter, a suitable active material (rubid, krypton or xenon) is placed between two parallel mirrors and excited from a special light source called "pump," which already surrounds the active material.

Energy from the pumping light source enters in the active material, causing them to emit light which is reflected back and forth between the two mirrors, where it is re-emitted. This light in turn transmits other atoms to emit light in a plane (reflected) with the existing light and

thereby greatly increases its intensity. If one of the two mirrors is slightly misaligned, the light within the active material will pass through and emerge as an intense beam of extremely small width. This extremely narrow beam width, which Ellis predicts will be reduced to only 0.2 of a second of an arc within a year, is one of the extremely useful characteristics of the device. Another is the fact that as bandwidths are extremely narrow. Low-power devices built to date have exhibited a frequency spread of only a few parts in  $10^6$ , and it appears that a spread of only one part in  $10^8$  or  $10^9$  can be achieved ultimately, Ellis said.

### Laser Receiver

In a laser receiver, both mirrors would be only partially aligned. This will permit passage of extremely graceful light from one mirror, as with the transmitter, and also will permit external light from a separate laser transmitter to enter through the other mirror. Additionally, the mirrors of the pumping light source would be re-aligned to just before the point where standardized operation (laser action) begins.

Under such conditions, when light from a separate laser transmitter arrives in one mirror, part of it will pass into the active material, triggering the standardized emission from the active material which will produce a much more intense (amplified) beam from the output mirror at the opposite end. The output will be directed at a photodetector cell to convert the variations in emitted beam intensity into equivalent electric signals.

Two important conditions must exist if the laser receiver is to operate as described, and these include the direct

with extremely useful properties:

- **Frequency (bandwidth)** of the receiving mirror transmitter beam must match precisely the resonant frequency of the receiver, which is determined by the choice of active material used and the physical spacing between the two mirrors.

- **Direction** of the incoming beam must be precisely aligned with the optical axis of the mirror. Otherwise the incoming beam will be reflected out of the material before it has made sufficient contact between the two mirrors to stimulate atomic emission. This means that a laser receiver will amplify only that fraction of any light beam falling on it which is very closely parallel to its axis, within a divergence angle which corresponds to the divergence angle of the beam emitted from a transmitter of similar design.

These inherent characteristics mean that a laser receiver is capable also to distinguish between a desired signal and unwanted background light, Ellis said. For example, a laser receiver can operate in bright sunlight and amplify a very weak signal from a comparatively low transmitter which enters its receiver even while partially ignoring the rest of the incoming sunlight.

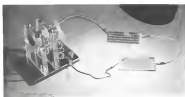
Even if a receiver mirror is pointed directly at the sun, it will not be receiving much amplifiable energy since it also will accept a bandwidth which is a millionth of the width of the visible spectrum, and a solid angle which is a few thousandths of the sun's disk as seen from the earth, Ellis said.

The laser receiver also has the advantage of not being subject to thermal noise as a most sensitive equipment because materials at normal temperatures do not produce significant light in the visible part of the spectrum, Ellis

forming air. While it is true that some modern engines (such as the turbofan) do operate with a very high rate of this light fall within the very narrow bandwidth and bandwidth of the device to be amplified better in some cases to be said.

The extremely narrow bandwidth of the laser transmitter, which can be further enhanced by using a small output current should enable a laser tube to achieve very long useful life without the power losses. The beam is filled and a large portion of its energy thereon will be reflected from a small object that has an air-coupled ring.

Advantages include the EIRP and low cost of the General Purpose GPS. However, it is noted that a laser tube capable of receiving distance from one spot which is similar with which it starts to understand should be able to measure this distance with an error of no more than one inch when the two vehicles are 100,000 m apart. In some cases the target vehicle has a down step of 20 ft. The laser tube will require an average beam power of only 10 mW. Complex laser tube system power consumption should not exceed 10 mW during either operation. The laser module (using total output) despite power consumption and is based on a standard 10% efficiency for the laser itself. This is said.



### Horshaw Develops Thin-Film Solar Cells

Californians replace the solar cells developed by Horshaw Chemical Co. design efficient power for solar panels to drive two propellers when only one is needed. Horshaw is one of a number of companies conducting research on thin film solar cells which give promise of reducing cost per watt and in light per watt of solar cells and allowing possibility of producing thin film solar cells.

When a laser tube is used to measure a spot, which is about 100 ft. in diameter, the laser tube will require an average beam power of only 10 mW. Complex laser tube system power consumption should not exceed 10 mW during either operation. The laser module (using total output) despite power consumption and is based on a standard 10% efficiency for the laser itself. This is said.

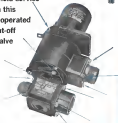
The laser also appears possible for measuring vehicle velocity by means of doppler shift of the reflected beam energy. At a relative velocity of 1000 ft/sec between a laser vehicle and a ground target, the doppler shift from the transmitted frequency will be one part in 100,000. This is more than the bandwidth of the returned signal which makes it extremely easy to measure the doppler shift.

A concrete leadspike hole from a B-70 is 30 feet—the largest in the world.



## LONG-LOK® self-locking screws...

simplify assembly  
and field service  
on this  
motor operated  
shut-off  
valve



Use of Long Lok Self-Locking Screws on this Swann-Scrimmer Corbin's Model 74 GIB Valve is indicated lock work, provided repeated use is made — standard field service. Long Lok Self-Locking Screws are used on the housing of this valve as well as on the gear train mounting where an extremely reduced assembly area makes the use of lock work a time consuming and prohibitively expensive operation.

Long-Lok Self-Locking Screws can speed and improve your assembly operations — provide important savings in time and labor — assure highest reliability.

Available in all head sizes and styles — have wide temperature range — qualified to MIL F 12240 specifications — meet or exceed for self lock identification.

If you have a fastener problem, Long Lok can help you. WRITE FOR CATALOG LL-81.



### Mach 3 Technology

## Torturing aircraft structures with the world's largest "gramophone"

To demonstrate flight stresses on an aircraft as advanced as the Air Force's Mach 3B-70 Valkyrie, it was necessary to make sweeping advances in the state-of-the-art of testing procedures.

One way the Los Angeles Division of North American Aviation met this challenge was to build the largest, loudest acoustic test chamber in the world. Here, a massive 47 foot by 30 foot concrete leadspike hole can blast aircraft structural specimens with up to 170 decibels of noise. This is the equivalent of 54,000 free tube radios going full blast, yet ingenious soundproofing keeps this noise to no more than a discreet whisper outside the lab. The noise inside the lab is so great that the best generated could ignite fiber glass insulating material.

Specimens, up to 6 feet by 25 feet can be tested in the acoustic lab. It has the capacity for progressive wave as well as reverberant sound fields; grazing or normal incidence specimen orientation; discrete frequency or random noise at sound levels up to 170 dba; thermal environment testing from -100°F to +1200°F; frequencies of 50 to 10,000 cycles per second. This is indeed a remarkable facility for structural testing, fatigue testing, and vibration testing.

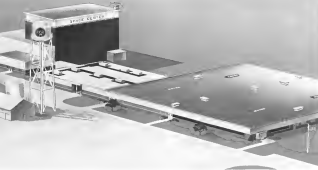
This giant acoustical laboratory can not only carry out testing on tomorrow's Mach 3 aircraft, but can perform tests on aerospace craft still ten years from reality. The lab is only one of the many that the Los Angeles Division has developed to conquer problems of space age flight.

Barriers of the B-70 Valkyrie

THE LOS ANGELES DIVISION OF NORTH AMERICAN AVIATION



## New RCA Space Environment Facility Brings Outer Space Down to Earth...



... Will protect causing generation of U.S. space vehicles and satellites at environmental extremes assuring reliable long life operation and optimum performance.

Included in the new environmental equipment and facilities being built and installed at the RCA Astro-Electronics Division at Princeton, N.J., are the following advanced testing devices:

**Vacuum-Thermal Chamber**—measuring 25 feet in diameter and 25 feet high to accommodate the varying geometries of space vehicles and satellites and meet all vacuum-thermal requirements.

**Vibration System**—provides 28 000 pounds peak force for sinusoidal and 28 000-pound rms force for random vibration testing.

**Temperature-Humidity Chamber**—so versatile it can

create virtually any thermal-humidity condition desired. Temperatures may be varied from  $-43^{\circ}\text{F}$  to  $150^{\circ}\text{F}$ , humidity from 0 to maximum.

**Rotary Acceleration**—supports subassemblies of space vehicles and satellites to forces as high as 200 g's.

The entire RCA Space Center, which contributed to the success of projects such as SCORE, TIROS I, TIROS II and ECHO I, continues to be dedicated to the conception, development and production of such state-of-the-art space vehicles and ground support and information handling equipment. For additional information about RCA's engineering talents and proved capabilities, contact the Manager, Marketing, RCA Space Center, Box 300 Princeton, N. J. And, for a complete description of the new environmental facilities, write for your copy of the brochure "RCA Space Environment Center."



The Most Trusted Name in Electronics  
RADIO CORPORATION OF AMERICA

shift and thus alter the vehicle's velocity. Ellis said.

For a doppler laser system, it is only necessary to design the sensitive sensor to its resonant frequency and be tuned to a frequency as much as one part in 100,000 away from the transmitter laser frequency, Ellis said. A variety of methods of altering the resonant frequency appear feasible, he added. One of the easiest might be to leave a small space between the end of the actual antenna and one of the two mirrors, which would be filled with an inert gas whose pressure could be externally controlled.

### Velocity Altered

In changing the density of the gas, the velocity of the light can passing through the gas is altered, which in turn will change the frequency (wavelength) of incoming transmitter laser light to which the receiver will respond. In varying the pressure of the gas through a suitable range, the sensitive frequency of the laser receiver could be altered through the required range of the doppler shift and a stabilized resonance occurred. This dual controlling the gas pressure could be utilized directly in terms of velocity.

For optical system where active materials cannot be substituted by a frequency differing by as much as one part in 100,000, another approach could be used, Ellis said. A small electrotransducer could be placed near the material to alter its resonant frequency, using a principle known as the Zeeman Effect.

A doppler laser system, capable of measuring both the magnitude and direction of a laser space vehicle's velocity relative to the sensor at an altitude of about 1,000 mi above its surface, to an accuracy of 0.1%, would require an average beam power of only 40 milliwatts, measuring instruments were made over eight seconds, according to Ellis.

More frequent and/or more accurate measurement would require higher beam power.

A doppler laser system of this type should weigh about 15 lb and occupy about one cubic foot, Ellis estimated.

### Lower-Beam Comparison

Ellis gave the following generalized comparison between optical sensor and microwave doppler systems, assuming the microwave system uses the state-of-the-art antenna in the sensor output system.

• If the distant object is large enough to fill the beam of both systems, as when measuring velocities against the surface of the moon or of a nearby planet, then a detectable doppler signal can be obtained for approximately the same amount of transmitter beam

power in both types of systems. However, the accuracy of velocity measurement is easily better for the laser system whenever vehicle velocity is not exactly perpendicular to the reflecting surface, as for a laser or planetary landing, because of the relatively large area covered by the radar beam which produces a large spread of doppler shift frequencies.

• If the distant object is very small and its position is not precisely known and cannot be determined except by extremely knowing of a large volume of space and at a wide range of possible doppler velocities, then the light se-

nsitive phase system about the same beam power for either type system—assuming the same response time.

• If the distant object is small, but it can be located by optical or other means to aid in obtaining the laser optical aim on the object, the power advantage shown for the laser and its advantage increases directly with the distance of the object. Even if a laser landing vehicle could carry a 66-ft-diameter radar antenna, a laser doppler system with only a two-foot sensor should provide velocity measurement accuracy which is 2,000 times better, Ellis concluded.

almost invisibly...



## trouble grows in tired metal

The enlarged piston section at the right has a fatigue crack. It is almost invisible to the naked eye, even though an inch inspection has been used to make cracks easy to see. If the inspection doesn't spot the crack at overhead, it will grow and become as dangerous as the one in the piston at the left.

Airwork uses two separate methods of piston crack determination, (1)

etching treatment, followed with a binocular microscope of the critical area, (2) X-ray inspection. We have some of the most extensive black light inspection facilities in the East.

You can't afford less than the best available inspection of your engine at overhaul. That's one more reason why an Airwork overhaul is good insurance of reliable performance.

**Airwork**  
CORPORATION  
Milford, New Jersey

ATLANTA • CLEVELAND  
MIAMI • NEWARK • NEW YORK  
BOSTON • WASHINGTON





## ...key to life

Water means power... water means raw materials... water means the life of the maritime nation. Still—more important of the mysteries of the ocean... it is only beginning to scratch the depths.

General Motors Defense Systems Division is vitally interested in all ocean phenomena. For example, new nuclear submarines and their engines of ballistic missiles emphasize one of America's most effective deterrents against attack. Water—aid the control of water—is vital to national defense.

Scientists and engineers in the laboratories of the Defense Systems Division are also hard at work in land, sea, space, astrophysics, biological sciences,

oceanography, geodesics, and basic research projects. R&D is dedicated to serving the Defense Department and other government agencies, in cooperation with many different branches of industry and scientific groups in fields of fundamental research and engineering through the coordination of knowledge, abilities, ideas and hard work.

General Motors is proud to contribute, through the growing Defense Systems Division, to the strength of America and human progress. Top-level scientists and engineers in all of these specialized fields will find new opportunities and challenging assignments as this fast-growing organization.

DEFENSE SYSTEMS DIVISION, GENERAL MOTORS CORPORATION, WARREN, MICHIGAN AND SANTA BARBARA, CALIFORNIA

## Lightweight, Compact Atomic Clock Built

By Barry Miller

Tenness, Calif.—Unusually lightweight, compact rubidium frequency standard, or atomic clock, which may have wide uses where competitive devices are too bulky, or too expensive has been developed and is being evaluated by Chascom Technology Corp. here.

The rubidium standard is one of a broad class of devices which utilize the atomic resonance phenomena in a gas to stabilize it to provide an accurate and stable output frequency or time standard.

Developed for laboratory and field use, the Chascom standard weighs 30 lb., occupies approximately 1 cu ft. and draws 40 watts during warmup, 20 watts during normal operation. The company is offering it for \$4,500 in single unit order. An airborne version of the rubidium standard could be packaged into less than 1 cu ft., according to Dr. Milton U. Chascom, president of the company.

The device is capable of providing output to an accuracy of 5 parts in  $10^{12}$  before accuracy is affected in the degree to which the output frequency deviates from an accepted standard. Stability—a measure of how well the device maintains its characteristics—is 2 parts in  $10^{11}$  (long term) and better than 5 parts in  $10^{10}$  (short-term); the company says. Short-term stability is related to the burn of a series of readings taken at one-second intervals and averaged over a period of about 10 sec.

Highly accurate frequency standards perform key functions in a variety of aerospace applications. These include synchronization in communications systems, timing for attitude and spin probe tracking stations in home frequencies, standards in scientific laboratories, timing in electronic instrumentation and timing and coordination for navigation and guidance systems.

While eventually needed to utilize rubidium frequency standards in its general mode of operation, the Chascom device incorporates a number of engineering modifications which reduce the bulk and complexity of electronic enclosures, contributing to the dimensionless size and weight of the unit. In the standard, as in earlier ones, the output frequency of a crystal oscillator selected at wave submultiple of the resonant frequency of a rubidium gas is multiplied and applied as feedback to a microwave cavity in which the gas is contained. Resonance is enhanced by the optical rejection from a partial only optically transparent beam. The amount of optical radiation absorbed in the gas is a function of the relative ab-



**COMPACT** rubidium frequency standard developed by Chascom Technology Corp. occupies approximately one cubic foot, weighs 30 lb. and is designed for laboratory and field use. Black cylindrical package at right contains microwave cavity, rubidium gas cell, control logic, phototronics and preamplifier.



**TYPICAL** circuit boards used in rubidium frequency standard. Circuit boards are employed in cylindrical optical microwave unit containing cavity and gas cell.

sorption of microwave energy. Since provides a measure of the departure of the microwave frequency from the resonance of the rubidium gas. An error signal derived from the detection of the transmitted optical radiation controls the optical modulation.

The output of the controlled optical oscillator then has to be translated back to an external crystal frequency (submultiple of the rubidium's 6,354,683.5 mc) into usable frequencies. This requires a

system whose complexity depends on the demands of the designer's choice of factors by which to divide the oscillator output and merge with a natural frequency. An important objective in the workbench design is to choose a combination of two factors to simplify the divisional circuitry and to eliminate the need for once control as used in other rubidium standards.

In the Chascom device, the crystal frequency output (4,433,130 mc) is 37

called in four simple steps: a decision by 6, 8, 5, 3, 2 and 1 again to provide a half division in a factor of 250. The resulting frequency is overlaid with the crystal oscillator output; the unwanted difference frequencies are filtered out and the true frequency is then up over 5 mc., one of several standard frequency outputs provided by the device.

#### Other Steps

Several other engineering steps were taken to simplify and economize packaging the device. In addition the company says it has analyzed and determined the reasons for loop aging and blocking, which frequently occurs in these devices if the loop is not properly excited. It says its design consists for this effect.

The miniature frequency standard is the first product of Cluser Technology, a firm acquired late last year (AVR Oct. 24, 1966, p. 54) by Cluser formerly vice president and director of the advanced research laboratory of Sperry Technology Laboratories, Dr. Donald J. Lerner, a senior scientist at Cluser is responsible for the frequency standard development.

## Acceleration Foreseen In Avionic Shakeouts

New York-Matrix, one of small electronic companies, will probably increase in the next several years as the industry's growth rate decreases, Henry W. Harding, president of Laboratory Electronics told the New York Speech of Science Analysts last month.

Predicting a drop to about 5% per year by 1975, Harding said "At this latest growth rate the industry is going to find it increasingly difficult to absorb and justify the extraordinary high cost of research and development and engineering of prototypes." Adding to this the effects of shifts in the market's nature, a reduced consumer population, he said, will result in the appearance of small companies. The LJE product said that the services, and consequent research of the bulk of prime defense Department electronic systems contracts will be "a constant shift from select groups of large firms able to adapt to such diverse technology."

Harding said that the industry can not expect the electronics portion of DOD's budget to expand in the 1960s as it did during the 1950s. Repeating a common view frequently voiced by other industry spokesmen, Harding pointed out that small and medium sized avionics systems, no matter how costly, the individual price tag, necessarily results in small total dollar volume.

## 000000 FILTER CENTER 000000

► **Aviation Circuit** by Year's End—Circuit engineers think prospects for launching an airborne radio communications network by the end of the year are still good. State Department is studying the foreign policy implications of the proposed radio network, satellite launch in Project Oscar (AVR Feb. 15, p. 77) which might be subject to a back with a government space shot. One source for the data, in approving the plan is that the proposed radio network is neither a government nor a commercial venture and hence falls outside existing rules.

► **Engineered Jamming Techniques** Reported—Recent government reports state that proper choice of jamming signal can result, use of power in the speech signal is likely to disrupt and distort speech, effective jamming. Dr. Donald W. Tufts of Harvard University, reported at recent Military Electronics Conference in Washington. The experiments also showed that effectiveness of an intercepting jammer is proportional to a high interception rate in need. Dr. Tufts said.

► **Military to Contract Maintenance**—An Air Force-sponsored study, by the Military Council of Air Force Defense Council SAGE direction center to compare effectiveness of military maintenance with private contractor personnel indicates that civilian personnel are probably as effective as their local civilian counterparts.

During last seven months of the ongoing study, the SAGE AN/TSB-1 computer was maintained by International Business Machines Corp. personnel after which AEC military personnel took over and maintained the facility. Under GIL maintenance terms, military personnel were 0.12% to 0.15% of total time, and mean time to failure dropped from 32 to 25 hours, but mean time to repair failure increased from 1.5 hours to 1.3 hours. In a separate report from the H. W. Adams and A. V. Morton of MIT at Military Electronics Conference.

► **New Filter Receiver Technology**—A new technique for design of ECM filter receivers, which permits continuous monitoring of a broad frequency range and simultaneous search for the frequencies of intercepted signals with an accuracy of approximately 5% was described by Dr. John L. Griggs of Applied Technology, Inc. at recent Military Electronics Conference. The bandwidth sensitivity of such a receiver would be approximately -70 dbm while covering the entire frequency



NIMBUS



Nimbus is the second step in NASA's research and development program to study weather technology. Differing from its predecessor, AWS, Nimbus will view the Earth at all times.

**Orbit**—Weighing approximately 550 lbs., Nimbus will circle the earth every 108 minutes in a 500 mile high polar orbit.

**Equipment**—As many as 6 TV cameras, plus infrared measuring devices, tape recorders, telemetry and command instruments will be contained in the satellite.

**Radio Acquisition**—Cloud pictures and other transmissions will be played back on command to U.S. meteorologists at Fairbanks, Alaska. Foreign scientists, also, will be invited to participate in the program.

**Control and Stabilization**—A specially built system will keep TV cameras always oriented toward the earth and permit cameras to view particular sectors of the global cloud pattern.

General Electric's Missile and Space Vehicle Department will provide systems integration for Nimbus, and will develop the control and stabilization system. NSVD is a department of the G.E. Defense Electronics Division.

GENERAL ELECTRIC

MISSILE AND SPACE VEHICLE DEPARTMENT, PHILADELPHIA, PA.

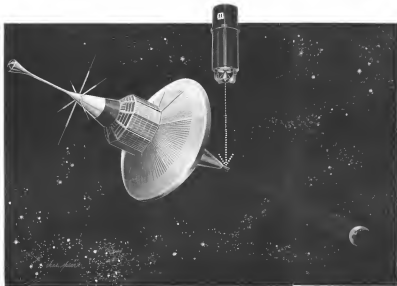
NIMBUS will be America's next-generation weather satellite in space. Continually viewing the globe with TV cameras and other sensors, Nimbus will help man forecast the weather and learn more about its causes. General Electric's Missile and Space Vehicle Department is constructing the space craft and providing systems integration for the system designed by the National Aeronautics and Space Administration.

GENERAL ELECTRIC



## Honeywell's IR Horizon Scanner

"Sees" from 100 to 60,000 miles



**Intensive research and development on the use of infrared for space exploration instruments gets special emphasis at Honeywell's Los Angeles Optical-Electronics facility.**

*Attitude sensing for satellites and planet exploration payloads to within 0.1° accuracy is possible with the unique design of the Honeywell LG61A Wide-Angle Horizon Scanner. Models of this infrared scanner meet a wide range of demands for attitude accuracy, life expectancy and range measurement. A scanner with no moving parts, using a semiconductor radiation chopper, is being designed for high reliability and long operational life. Further variation of the basic design provides for operation over the extreme attitude variations required in eccentric orbit missions.*

Other infrared programs at Honeywell include the development and production of infrared detectors, surveillance and reconnaissance systems, communications systems, scanners and trackers, in-flight automatic refueling couplers and IR instrumentation devices and systems.

For further information on new developments in Optical-Electronics, call your nearest Honeywell representative, or write: Honeywell Auto Division, 1915 Arroyo Ave., Los Angeles 25, California. Sales and service offices in all principal areas of the world.



**IR Detectors** Typical Honeywell IR detector and parametric preamplifier. The PPM (photoelectric multiplier) cell operates at 1000000 voltages, can be cooled, and has a spectral response from 1.8 microns. Models will also produce cooled detectors for military and space applications.

**Communications** Honeywell's MAXIMUM™ (Maximum Security Community) model instrument uses an optical chopper and is modulated in liquid crystals. Line of sight communication path security can be obtained in either lock, hold, wait, transmit and sensor design. MAXIMUM provides the correct rugged, portable instrument design. \*Patented



**Radiometers** Honeywell has produced infrared radiometer instruments (typical shown) for a wide range of applications from the medical field from 0.7 to 40 microns.

## Honeywell



*Military Products Group*



## WHAT'S SO HOT ABOUT THIS 3 LB. THRUST?

It is a plasma jet, formed at more than 18,000°F and accelerated in a magnetic field to triple its specific impulse. It is being developed in Northrop's Space Propulsion Laboratory as a propulsion system for maneuverable satellite vehicles and spaceships. Its measured 3 pound thrust and high efficiency make it a leading candidate for the first true space drive.

In space, where gravity and friction are forgotten and acceleration time is relatively long, low thrust, high impulse engines like this offer a much more promising approach to space travel than most other

types of propulsion. By looking at this theoretical problem from a solid engineering point of view, Northrop bids far to revolutionize space propulsion.

Northrop's approach to magnetohydrodynamics is reflected in almost every phase of space technology. Wherever men, machines and space are coming together, Northrop techniques and experience are helping to find solid, practical answers.

**NORAIR**  
A DIVISION OF  
**NORTHROP**

range of two to four gigacycles, Gengly said. Because output could be designed on a cathode ray tube with an angle displacement of the CRT beam with respect to the jets and separating the frequencies and its solid displacement representing the amplitude of the intercepted signal. A complete review of the new type is expected to weigh 10 lb. and occupy about one cubic foot, Gengly said.

■ **New Multilobe Superconductor Developed** — New superconductor material whose cold-venting alloy is not brittle and strong enough to be fabricated into wires, bars and strips without loss of its superconducting properties has been developed by Thomson International, a division of North American Aviation under sponsorship of the Atomic Energy Commission. New material consists of three parts modulus to one part aluminum. Company says that new made of new material has conducted 100,000 ampere per square centimeter at a 90,000 gauss field at liquid helium temperatures and is expected to sustain superconducting in over 100,000 gauss.



**Polaris Antenna**

Retractable whip-type high-frequency radio antenna for Polaris submarines developed by Hellman Electronics Corp. was received of testing its cover spectrum between 2 and 32 mc. as shown at model above. Landing coil, in the form of helix forms part of antenna so that any energy emitted by helix is added to that from the rest of the antenna. Miniature resonant coil feeds helix at one point; clamping of helix electrical length of antenna system for broadband operation. Radio operator's control presents antenna and the helix to be moved in forward or rearward. Entire antenna can be withdrawn into submarine within 40 sec., Hellman says. Antenna can also feed one or more T-type mode slots.

## GALLERY PROPELLANT BRIEFS



Let's talk impulse in space

Exotic chemical propellants will often find their most useful applications in upper stages, for course or orbit correction and lunar landing or take-off. Isp values compared at  $P_c=0.2$  psi have a different relationship than when compared at  $P_c=14.7$  psi. Such an approximation of "space" conditions gives a much truer picture of the relative performance of propellant systems. We present (from Gallery's new booklet — *Propellant Performance Data*) a few excerpts to illustrate the point. As the U.S. standards on LOX-RP, LOX-LH<sub>2</sub>, and solids, there is still considerable room to develop liquid systems for specialized jobs in space.

PROPELLANT SYSTEM	SPECIFIC IMPULSE	
	(Sea Level) 1000-14.7	Space 1000-0.2
H <sub>2</sub> -O <sub>2</sub>	391	400
H <sub>2</sub> -N <sub>2</sub> O <sub>4</sub>	357	465
H <sub>2</sub> -F <sub>2</sub>	360	460
N <sub>2</sub> H <sub>4</sub> -F <sub>2</sub>	363	438
H <sub>2</sub> -F <sub>2</sub> -O <sub>2</sub>	327	421
H <sub>2</sub> -F <sub>2</sub> -F <sub>2</sub>	328	412
H <sub>2</sub> -N <sub>2</sub> O <sub>4</sub>	318	405
H <sub>2</sub> -N <sub>2</sub> O <sub>4</sub>	306	391
H <sub>2</sub> -Cl <sub>2</sub>	268	380
H <sub>2</sub> -O <sub>2</sub>	250	379
H <sub>2</sub> -Cl <sub>2</sub>	250	368
N <sub>2</sub> H <sub>4</sub> -F <sub>2</sub>	251	354
CH <sub>3</sub> -N <sub>2</sub> O <sub>4</sub>	278	340

\*Available upon immediate request from:

### Gallery Chemical Company, Defense Products Department

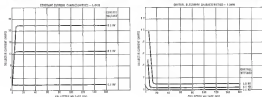
Hawthorne, Calif. Phone: 366-1111. Telex: 366-1111.  
New York: 1507 Lenox Street, Van Nostrand, N.Y. 10017.  
Washington: D.C. 100-2000. Cable: Gallery. Telephone: 444-0000.  
Detroit: 10000 Bufile 12-1000. For 1965: 10000 Bufile 12-1000.





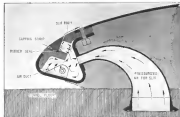
MODEL 15-11 - 150KV-20A

## NEW LITTON INJECTRON® HOLDS OFF 150 KV, SWITCHES 20 AMPS



"An advanced concept by Litton for high power beam switching with high efficiency and fast rise time. Requires only low control voltages. Collector current is largely independent of collector voltage, resulting in prede-termined current characteristics. Ideal for floating deck modulators for switching modulating mode klystrons. 1.200V is in field operation now. Other models for cathode switching to 750 amps, 350 KV coming soon. Contact us at San Carlos, California, for more information.

**LITTON INDUSTRIES**  
Electron Tube Division  
MICROWAVE TUBES AND DISPLAY DEVICES



ANTI-ICING AIR is supplied to the leading edge and sent through the leading edge slot.

visibility of entering the lower surface of the wing by providing wall insulation. In this case, 0.075 in. wide flexible grooves have been made in the plane surface.

Blackburn tests on the system in the Naper anti-icing tunnel at Afton, Ill., on Naper's four Laminar air wing being tested. One series of tests was on effect of incidence, with sweep back using half a tailplane section mounted vertically on top of the Laminar housing. Tailplane has a 0.087 in. wall blowing air at 45° of the chord. It could be raised open to its blowing stage. Blackburn had a 30-deg sweepback, a 70-in. span and 42 in. mean chord.

Most 15 ft. of tubing was done in controlled conditions at ambient temperature of -10°C and with anti-icing temperatures up to 23°C and pressures up to 20 psi. That night's wind from 3.00 to 23.00 hrs. (3) ft. span. Eight tests were made at 1.5 ft. with droplet sizes of 27 microns and 0.4 gms/m<sup>3</sup>.

After collection, Blackburn concluded that "generally the difference is in proof of wet better than the common hood test gas systems. In fact, Blackburn now shows wet back of the leading edge and near in front of the slot."

Incidentally, according to the engineers, usually were between 75° and 115° at the leading edge on the upper surface and 75° and 115° on the lower surface. No ice formed for angles of incidence between +1 and -1 deg.

Blackburn claims that anti-icing of higher design speeds would be better than tested results because of use of surface temperature due to dynamic heating, which was not considered in the tests.

For boundary layer control integrated with the anti-icing system, an in-duct

off from the end of each engine compressor through a bleed taken toward the cone perimeter of the engine casing. Air flow is fed through two ducts in parallel, one of which can be closed to a common duct between the two engines which serves as the source for all air bleed supply.

Pressure indicators fitted at the wing and tailplane tips give a good indication that the system is functioning. In flight, the system is actuated normally after air conditions are shown by an icing detector.

Barney, grooves and temperatures are high for boundary layer control on the order of 160 psi at 22°C; the pressure is reduced 25 psi for anti-icing. However, temperatures remain about the same and in case with the ducts is made of welded stainless steel sheet and have optional subducts. Weight penalty for the system is comparatively slight: 0.25% of the gross weight.

Important advantage, Smith and Jones pointed out, is that the system can be used during ground engine run-in. It is also not so limited on the ramp.

Smith and Jones also noted that there is a question as to whether there is a serious wing hazard when flying long distances at low level, a region for which the NARS is designed at high subsonic speeds. This had been a little problem to work from in this aspect but "anti-icing is available at low speeds."

In another discussion, D. G. Brown of ASES (Aircraft Design) Ltd., claimed that flight design now provides a simple and efficient means of deriving and using interest in the method appears to be with air cargo freighters, STOL, and executive aircraft.

In the STOL field, Towner and that

QUICKEST, EASIEST WAY TO MEET CRITICAL TEMPERATURE CONTROL SPECIFICATIONS . . . A

## KLIXON® THERMOSTAT PACKAGE!



KLIXON thermostat packages, custom-designed for your particular application, are the most reliable, accurate, and easy to install. They are the only thermostat packages in this specific developed design problem. Typical of the many KLIXON systems, these thermostat packages are designed to operate in a wide range of temperatures. With two built-in KLIXON 501 processors, they allow thermostat control of the cooling system of a high powered magnetron located in the radio antenna head at a remote time zone.

This is just one of the many KLIXON thermostat packages now in use with similar value and cost-effective components. Where reliability is a prime requirement, it's now here. A thermostat design problem, used as your specifications. Our special packaging team will design, test and deliver to meet your schedule. For complete specifications and mounting options, send for booklet PEST-1 today.

**METALS & CONTROLS INC.**  
3507 Forest St., Arlington, Mass.

A Complete Division of

**TEXAS INSTRUMENTS CORPORATION**



# "FORGING MILITARY SPACEPOWER"

## USAF SYSTEMS COMMAND ISSUE

SEPTEMBER 25, 1961

On September 25, AVIATION WEEK and Space Technology will publish one of the most important issues in its history... "FORGING MILITARY SPACEPOWER" - USAF SYSTEMS COMMAND ISSUE. For the first time, the complete story of the newly activated USAF Systems Command will be presented to the aerospace industry throughout the world.

The new Systems Command will serve as a single agency to control R&D and procurement of all aircraft, missile, aerospace and space systems for the USAF from the idea stage through the time they are in the field ready for use. This concept of a single agency for both systems R&D and systems procurement will have penetrating impact on all aerospace industry companies selling hardware or

research services to the Air Force.

The Systems Command will control approximately \$15 billion in contracts and annually will award \$7-8 billion in new contracts making it the most important single source of aerospace industry business. Further evidence of the impact on industry are policy and procedure changes which can be expected in many areas such as technical approach, contract competition, proposals, cost estimating, management structure and subcontracting.

These are just a few of the important details to be covered in the Systems Command Issue, which will constitute a new handbook in doing business with the Air Force. Teams of AVIATION WEEK editors are now visiting the various bases of the Command for full, complete reports. Detailed edi-

tional coverage will be given to procurement, organization, plans and programs, policies, procedures and future technical activities.

AVIATION WEEK is privileged to present this edition to the industry covering our newest and vitally important Command. Prime contractors, subcontractors, suppliers and firms doing R&D work for the Air Force will be extremely interested in this new issue which will lay the groundwork for future contacts with the Command. It will supersede all previous editions on USAF research, development and procurement policies.

Your company is urged to participate by advertising its capabilities and facilities for the furtherance of the defense effort. Write, wire or call collect for space reservations.

**Aviation Week**  
— Space Technology

A MCGRAW-HILL PUBLICATION  
300 West 42nd Street, New York 36, N. Y.



TODAY'S  
ECONOMICAL  
AIR FREIGHTER

# ARGOSY

**HAWKER SIDDELEY AVIATION**

32 Duke Street, St James's, London SW1

when available, are used, fluid distributors can easily be fitted. Linked to a flexible hose to the fluid supply tank, receiver agencies prefer the simplicity and easy freight, which use pump generators, connected enough but not from the source. Canada, also a studying the application of liquid devices to higher speed aircraft and helicopters, but Taurus stressed that there are more problems to be solved before any solid core engine can be considered fully developed.

He remarked that the electric cycle engine has been more fully explored than any other, but added that he doubted it could match the fluid system for lightness. T.R.S. has had a high engine design test rig in operation since 1955, in a comprehensive program and has run considerable flight tests using a Rotax Aviation Two Power and de Havilland Three.

Electrical design of helicopter blades has been a major project of Napier's. The company recently developed and developed the system with Westland Aircraft for the Westland Wessex. Test program was conducted at Ottawa, Canada, last winter at the wing simulator facility, operated by the Canadian Research Council.

R. D. Clark of Napier, said that more major blade air has a negligible effect on the lift coefficient at normal angles of incidence and while most effect is an aerodynamic lift can be sustained by a steady increase in power.

However, due to blade flexing, vibration and high centrifugal forces, the ice does not always stay on the blade and self shedding keeps the helicopter safe. But, Clark warned, self-shedding can cause damage to the tail rotor from flying debris of ice and also if self shedding is not immediate, out of balance vibration can be set up.

Napier's system is designed to shed ice in small enough pieces as to not cause structural damage and to shed it symmetrically.

For the Wessex helicopter, Napier developed heater mats which are built, standard. Spent heater elements, designed for carburetor shedding. On each blade there are six heater elements running spirally from one-third rotor radius to the blade tip. The mats are placed at the top and have a single precision engine return burner.

Tail rotor mats have a single element on each blade, covering the full span with only a small wraparound area downwind, symmetrically placed about the leading edge.

Crack and fatigue tests with spin rigs mats attached to blades have shown that the mats do not detract from fatigue life of light alloy spars and that the spars fail before any sign of test test failure.

As for the advantage in that most are premanufactured so blades do not have to be shipped to a special facility. Main rotor mats are protected at the leading edge over the subsonic section by a stress-grip which fail against erosion and stress damage. Tests of this fail were made at speeds up to 600 mph by Napier and the Royal Aircraft Establishment, Farnborough.

## PRODUCTION BRIEFING

General Electric Ordnance Department has a \$1.66 million National Aeronautics and Space Administration contract for continued development of the Project Spas engine program, designed to operate at a temperature of absolute zero. Project has been funded by the Army and Navy for the past two years.

Virginia-Carolina Construction Co. will build a Scout launch vehicle assembly plant at Williams Bluff, Va., under a \$991,195 National Aeronautics and Space Administration contract.

Martin Orlando Division has received a \$2.25 million Air Force contract to begin production of the nuclear powered Ballpark 8 anti-ground missile.

ARCO, Inc., has a \$259 million Air Force contract for management, operation and maintenance of USAF's Arnold Engineering Development Center.

Radio Corp. of America has a \$495,580 cost plus fee contract to continue production of T-100 weather satellites for NASA and to provide purchase, launch and engineering support for T-100 operations.

Massachusetts Institute of Technology has won a \$493,000 NASA contract for research, development and laboratory study of the Apollo guidance system. Estimated cost of the contract is expected to be \$1.1 million.

West Germany will build ground stations enabling it to participate in National Aeronautics and Space Administration's Project Rhea, and Redwood communication satellite with NASA-Gesellschaft agreement to similar order with Great Britain and France.

Rennette Inc., Santa Monica, has developed a radar testing system, R-18 (1), for checking all radar such as air force, military, and police and is now working for Republic Aviation Corp. for installation in the R-1805 light-bomber.

## PROBLEMATICAL RECREATIONS 76



A bunch of the chips from World dropped out a nearby pub, there were four parties: 25 physicians, 20 engineers, 18 productivity managers, and 12 computerists. Altogether they spent 6 pounds sterling, 13 shillings. It was found that 5 physicians spent as much as 4 engineers, that 17 engineers spent as much as 9 productivity managers and that 6 computerists spent as much as 1 computerist. How much did each of the four parties spend?

—Contributed

Recent tests, capped by a successful rocket sled run, have proven the capability of the Leningrad navigation system to function in month movements. The 30-pound P-100 stable platform, inside of the system, remained as accurate during the test. Peak acceleration acceleration was as much as 10 g's. If you're in the instant guidance quarter, look into Leningrad Systems.

ANSWER TO LAST WEEK'S PROBLEM: The time must have been 43 7/81 days just two a day.

\*Current rate of exchange: 1 Pound Sterling is 26 Shillings at \$2.85.

**LITTON INDUSTRIES, INC.**  
Beverly Hills, California

Work better, live  
better in the unspoiled  
Pacific Northwest



Some like Jane Allen, your answer is only a word or two in Seattle.



## Career openings for Tool, Production, Packaging Engineers

Being the world leader in the field of jet transportation, as it works on advanced jet transportation systems of the future. These long range programs offer tool, production and packaging engineers outstanding opportunities to move ahead in their special fields.

**TOOL ENGINEERS** Assignments involve creating layout and design of jigs, jigs, loading equipment, spot weld and machine fixtures, and special tools for production of airframes and associated jet aircraft. Requirements: a BS degree in engineering, preferably mechanical or civil. Experience in aircraft tool engineering desirable.

**PRODUCTION ENGINEERS** Duties include establishing a production line, determining by parts, subassemblies, major assemblies, installation, etc., in accordance with an overall manufacturing plan, as well as establishing the sequence of the manufacturing process, and the timing and storage of materials, parts and assemblies throughout the process. Previous aircraft experience in tool and production planning is desirable.

**PACKAGING ENGINEERS** Applicants must be graduate engineers, or possess the training and experience needed to develop packaging to protect electronic equipment, and involve and aircraft components, from shock, vibration and environmental conditions. Assignments may include laboratory testing and evaluation of packaging materials, methods, techniques and shipping containers for protection of flight and airborne units, as well as research into susceptibility of units to damage from exposure to shock, vibration and moisture.

Scholar—completing graduate work experience—range from \$1,000 to \$14,000. Training assignments are available on a voluntary basis to holders of an engineering degree. Boeing pays travel and moving expenses. U.S. citizenship is not a requisite.

At Boeing you'll enjoy the advantages of being in the unspoiled Pacific Northwest. Access for mid career advancement, excellent recreational facilities, modern housing and fine schools.

### BOEING TRANSPORT DIVISION

*Mr. Jane Phillips, Personnel Director, The Boeing Company, P.O. Box 357, 15700 Aviation Way, All qualified engineers will receive consideration for engineering positions regardless of race, color or sex.*

NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

EDUCATION \_\_\_\_\_

PROFESSIONAL REGISTRATION \_\_\_\_\_

MAIL TO: THE COMPANY, 15700 AVIATION WAY, SEATTLE, WASHINGTON 98148



Northrop N-156 equipped with arrester cable refuel tank, is run up for takeoff from non-prepared sod runway at Calver City, Calif.

## Northrop N-156 Operates From Hard Sod Runway



Sod runway tests are performed with the N-156 to prepare for evaluation under similar conditions are made by Army and USAF schools in various tactical fighter competitions. This included an impact which varied between 0.2 in. and 0.5 in. Takeoff roll was 2,400 ft. at 12,000 ft. gross weight. Slight modifications of the Boeing gas tanks was required to accommodate the 22 x 7.7 in. tires originally designed for the Gemini 3-16. Test airplane was equipped with non-production engines. Shallow engine, Northrop officials said, should shorten takeoff roll. Third engine runway takeoff roll was increased about 150 ft. by the tires.





Left: Test-firing of large, lightweight solid propellant rocketed UTC Development Center is important phase of multi-million pound thrust booster development program.

## SOME OF THE AREAS IN WHICH MAJOR PROGRAMS CURRENTLY ARE BEING CARRIED FORWARD AT UTC

Chemistry and molecular physics of high polymer systems and fundamental mechanical properties of heterogeneous systems

Theoretical propellant performance predictions and experimental determination of reliable performance parameters of propellants.

Development of high temperature materials, refractory metals, ceramics, and vitreous glass reinforced plastics, metal plastics and impregnated ceramics

Capability backed by four decades of pilot-plant experience



**UNITED TECHNOLOGY CORPORATION**

P. O. Box 358, Sunnyvale, California

A subsidiary of United Aircraft Corporation

Optimization of solid propellant processing techniques and development of process methods for new propellants and motors

Study of combustion of solid fuel and liquid oxidizer, establishing principles of injector design and grain configuration

Investigation of design criteria for metallic and nonmetallic rocket cases, nozzles and component hardware

Studies of heat transfer, thermodynamics and aerodynamics of rocket motors, stress analysis of structural design

Patents currently available in these and other areas

Process engineer  
Design engineer  
Structural analyst  
Reliability engineer  
Polymer chemist  
Physics chemist

All qualified applicants will receive consideration for employment without regard to race, color, creed or national origin.

## Is there a future for you with UTC?

Are you an engineer or scientist with a record of achievement?

Would you enjoy applying your talents to major programs in advanced propulsion—large powered solid propellant rocket engines, hybrid rocket engines and storable high energy liquid propellant engines?

Would you find it stimulating to work directly with recognized professional leaders at a modern multi-million-dollar complex, where you could use yourself of the very latest techniques, methods, ideas and equipment?

Would you appreciate living in the San Francisco Bay area, which features "West Coast living" at its finest? Plus the possibility of financial gain if you can give evidence of real creativity and initiative? This is what the future holds at UTC. If you are interested, we invite you to contact C. P. Gieseler, Dept. 166-A, United Technology Corporation, Box 358, Sunnyvale, California. All replies treated in strictest confidence.

## EQUIPMENT

# Tri-Axial Airline Seat Limits Acceleration

By David H. Hoffman

Washington—New airline transport seat first responds like a shock absorber to ground impacts but has been designed to protect passengers from spins or darts in survivable accidents.

Conceived by Fred B. K. Lauer and L. M. Patrick of Wayne State University, in Detroit, the triaxial acceleration seat was controlled movement to dampen the post-impact forces imposed on a passenger during sudden stops. The forward facing seat, constructed to furnish protection on any axis, also would distribute impact forces over a passenger's entire body, opening skeletal joints and vital organs from uncomfortable pressures.

Basic purpose for the seat's design is that the average acceleration level generated by a typical airline accident—ranging less than 150 mph, impact angle less than 30 deg—is well within common human tolerances.

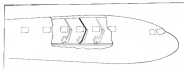
A shockingly small number of passengers survive these accidents, Lauer and Patrick report. "Because their seats pull them free, they are struck by flying objects, their heads strike adjacent structures as they are ejected."

Most of these deaths stem from the fact that aircraft deceleration during a crash landing is not constant. Thus the passenger is exposed to a series of impacts and will react and feel before the tolerance of the seat itself is in a bind. The "evening" of these forces—whether vertical, longitudinal, lateral or any combination—is the seat's prime purpose.

### Manufacturers' Interest

Nature Wayne State University has the two professors intend to license the Tri-Axial Acceleration Seats to aircraft manufacturers.

As the program required of most new airline accidents, however, in cases where have been recovered from several airline seat manufacturers and they use do the testing with their hands if they like the design. According to Paul



SUPPLEMENTATION would limit acceleration, spread forces over passenger's entire body.

Patrick, the seat could be incorporated in new aircraft or "renovate" existing seats.

Existing deceleration experiments conducted by the National Aeronautics and Space Administration Air Force Civil Engineers, as authors on deceleration effects, and their own work with the vertical acceleration at Wayne State, Lauer and Patrick, concluded that their seat should withstand 40g for 50 milliseconds in the vertical plane, 30g for 50 milliseconds in the longitudinal plane and 20g for 40 milliseconds in the lateral plane.

To obtain such resistance, the new seat would:

- Automatically place reclining passengers in a more upright position to lessen their acceleration tolerance. Seat travel in this position would be in the direction of aircraft motion thus reducing the g forces imposed on a passenger.
- Move with respect to the fuselage so as to absorb peak accelerations. Actual deceleration of energy through controlled movement would change "step back" at the end of travel.

- Control of a metal shell foundation suspended from the cabin ceiling and attached to the cabin floor. Designed for controlled deformation under load, the metal shell of the seat would begin to yield at the threshold of its own acceleration tolerance and then

time to yield throughout the time this tolerance was exceeded.

When force is applied to the seat, energy absorbed in the seat suspension—single resistance in crushing elements—would limit acceleration within permissible limits. Vertical acceleration forces would be counteracted by the seat's spring suspension, while horizontal acceleration forces would be absorbed by both crushing suspension and floor attachments.

Unbroken restraining of the supports and cushions contained by the shell would place a passenger in a more reclining position for comfort. As the passenger seat shifts forward at its bottom to permit the back to slope, the metal shell remains in its upright position.

### Reclining Mechanism

Reclining acceleration while the seat is inclined possibly would be more or less perpendicular to the longitudinal body axis. "In this direction," according to Lauer and Patrick, "the body was subjected the greatest acceleration and there is no reason to return the passenger to the vertical position. On the other hand, if the acceleration is axially longitudinal only, then the passenger will be returned to the normal seated position by the forces which tend to move him back in the seat, and the reclining mechanism will be so designed to prevent these forces to return the passenger to the upright position."

The two Wayne State professors also realize that the use of reclining seats requires will allow a device to suit might of present safety standards are not used. If of more acceleration resistance is demanded, ceiling floor suspension will furnish it without additional weight penalty. With an allowance for "loss or other falls added

## Tri-Axial Seat Specifications

Seat Axis	Maximum Passenger Acceleration	Peak Acceleration in G's Sustained	Peak Acceleration Time Limit	Seat Travel in Airplane Peak Acceleration
Vertical	30g	40g	50 milliseconds	4 in.
Longitudinal	30g	30g	50 milliseconds	12 in.
Lateral	20g	20g	40 milliseconds	2 in.



# SHILLELAGH

U.S. Army Missile System



The SHILLELAGH is being developed for the U.S. Army under the overall direction of the U.S. Army Ordnance Corps.

The United States Army SHILLELAGH surface-to-surface guided missile—like its Irish namesake—will be simple, reliable, lethal. Against enemy targets—moving or stationary—SHILLELAGH's accuracy and firepower will provide the U.S. Army a devastating new weapon that kills with a first-round probability approaching unity ... and at ranges never achieved in antitank warfare. SHILLELAGH is now under development at Aeronutronic, prime contractor on this advanced weapon system.

AERONUTRONIC DIVISION *Ford Motor Company*, DEFENSE PRODUCTS GROUP  
FORD ROAD, NEWPORT BEACH, CALIFORNIA



SHILLELAGH is one of many advanced programs currently under development at Aeronutronic's new, million-square-foot Engineering & Research Center at Newport Beach in Southern California.

Write for information about Aeronutronic's capabilities and career opportunities now open for engineers and scientists.



## scientists and engineers in a unique leadership role

The frontiers of space science and technology are being expanded at Aerospace Corporation. The scientists and engineers of this leadership organization are the critical civilian link among government and the scientific/industrial teams developing space systems and advanced ballistic missiles. In providing broad scientific and technical leadership to every element of this team, they are engaged on a balanced program of scientific inquiry by the spectrum from basic research and forward planning through general systems engineering. Included in the latter are technical representation, integration and review of the engineering, development and test operations of industry to the extent necessary to assure achievement of system concept and objectives in an economical and timely manner. These people are privileged to view both the state-of-the-art and system development in their totality. Now more men of superior ability are needed—highly motivated scientists and engineers with demonstrated achievement, maturity, and judgment beyond the name. Such men are urged to contact Aerospace Corporation, Room 101, P. O. Box 95031, Los Angeles 45, California.

*Organized to the public interest and dedicated to providing objective leadership in the advancement and application of space science and technology for the United States Government.*

**AEROSPACE CORPORATION**



**REAR-FACING** fixed seat has top-and-bottom adjustment points.

for appearance only, too," Luttwak and Patrick estimate that seat is roughly 35 lb.

Dykeman details of the new seat design, which was developed under a U.S. Public Health Service grant, were disclosed here at a conference called by Federal Aviation Agency to sound out industry's views prior to reviewing the so-called countermeasures regulations. Calling for a comparative evaluation of forward versus rearward-facing seats on subject transport, the Air Transport Line expressed doubt that passenger protection in survivable aircraft could be increased by converting present seating arrangements. ATA said:

"There is much evidence from crash investigations to make one wonder if removing the seat would truly provide additional survival protection to the passenger. As a matter of fact several qualified researchers in the field can state that forward-facing seats actually provide the greatest advanced safety."

### Shortcomings Cited

ATA then cited some of the aft-facing seat's possible shortcomings. "Angular deceleration" might force the passenger's head from the seat support and head at backside the passenger's body might "slid forward" over the seat back if the seat were inclined backward more than 30 to 35 deg. at the time of ground impact the position of an aft-facing passenger's center of gravity would require positive stress on a seat's attachment and tend to tip it back the floor during a crash landing, and the aft-facing passenger's head would not be protected from fi-

ring objects dislodged from luggage shelves by the crash's impact, ATA observed.

Skinner, Luttwak and Patrick, held that their seat's contoured shell and self-extending mechanism would assure the chance of a passenger's being dislodged by vertical or "angular" adjustment considerations. To the contrary, one that aft-facing seats fail at about half the g load maintainable by forward-facing seats, they note that the assumed reversal of standard airline crash force seats.

When such standard seats are reversed the load during a crash is applied at a higher point on the bod-

then would be the case in a forward-facing seat. This results in leverage that causes seat failure. Its supporting the seat from both top and bottom, this leverage can be minimized.

### Passenger Reaction

The objection that passengers in rearward-facing seats are not protected from being ejected can be discounted, the designers believe, by tying the potentially dangerous shroud down and dividing the cabin into compartments. At the same time, ejection is area would be protected by aft-facing seats so that they would be forced toward their points, not wrenched away from

## STRUCTURAL DYNAMICS

Advanced engineering design preferred.

To evaluate the behavior of structural and complex stress vibrations and shock transmission on structures and components.

Analyze mass and elasticity parameters of systems and estimate response characteristics using extensive digital and analog computer facilities. Monitor all test data and derive substantial laboratory tests for stress and vibration.

## STRESS ANALYST

Advanced engineering design preferred.

To insure structural integrity of designs through a combination of analytical and experimental methods.

Assist in the proposal and development of maximum weight structural analysis of surviving extreme environments.

Assist in the planning and evaluation of structural tests for development and verification.

Develop new and improved analytical methods of structural analysis.

②③④

Sandia's Livermore Laboratory offers many advanced and specialized facilities to further work of its scientists and engineers. Liberal employee benefits including generous vacation and health insurance and retirement plans. Excellent food services. Add to Sandia's attractiveness as a place to work.

Located on the San Francisco Bay area, Livermore offers numerous advantages close to metropolitan San Francisco.

If you are interested in a career at Sandia, write to Personnel Division, 252

**SANDIA CORPORATION**  
LIVERMORE, CALIFORNIA

All qualified candidates will receive consideration for employment without regard to race, creed, color, or national origin.

them, according to Lussier and Patrick. Dismissing the popular airmen view that passengers would object to riding "backseats," Lussier and Patrick cited an independent, confidential survey of 11,800 Military Air Transport Service passengers riding in aircraft seats which indicated that only 17% objected to the arrangement. A negative reaction to riding in rear seats would be a "psychological response that probably would not last after a ride of a few minutes duration," they contend.

FAA has taken no position on the affecting seat question. Pending for their study, the agency will consider

other seat-jointing requests at the conference here.

- Air Line Pilots Assn., disappointed with the quality and volume of research on transport cockpits since 1955, announced that more evidence be accumulated before affecting seats are requested for regulation. ALPA also urged that the FAA and the aircraft industry concentrate on the conditions around airports that the union believes have been responsible for the bulk of recent airline accidents.
- Cal Stage favored air-lining seats. He also urged FAA to "subsidize" safety by paying the cost of retrofitting airline fleets with forward seating arrangement.



B-70 Fuel Filter

More fuel filter for the North American B-70 bomber is a lateral chamber steel cylinder measuring 36 in. high and 14 in. in diameter. The unit then fit into a narrow fuselage larger than 74 inches with less than 1 in. clearance. Smaller filter at each of the aircraft's six General Electric J43 engines will screen particles over 40 microns. Filter is produced by Alkath-Finco Metals, Inc., a subsidiary of Fiat Corp., Glen Cove, N. Y.

- result in them installed on most MAXT aircraft.
- Civil Aeronautics Board stated that a properly designed air-lining seat could contribute to passenger safety. However, the Board would not recommend any regulation requiring such seats at present.
  - Aerospace Industries Assn. rejected the air-lining seat concept until more conclusive evidence indicates the seats would enhance safety.
  - Air Force Institute of Technology rejected air-lining seats without crash facilities.

## Automatic Landing Seen for Caravelle

Leas, Inc., and Sud Aviation of France have signed an agreement for the development of a wholly automatic landing system for the 561 Caravelle transport.

J. J. Downes, vice president and general manager of Leas's International Division said that the primary objective of the agreement was "... to have present maximum weather restrictions for aircraft operations and provide safe, automatically controlled, fully automatic landings."

Leas's American Division, Santa Monica, Calif., is conducting the program, using a B-70 test aircraft which will serve as a testbed for the Caravelle installation.

## ELECTRONIC ENGINEERS & PHYSICISTS

# REPUBLIC AVIATION NEWS

## NEW RECONNAISSANCE ROLE FOR "ELECTRONIC PLANE"

### NEW PRIME CONTRACT AWARDED REPUBLIC CREATES DEMANDING ASSIGNMENTS FOR EE's & PHYSICISTS

The development of a reconnaissance capability for Republic's F-105D marks the first "transition" of an all-weather reconnaissance system with an all weather electronic weapon system. The new F-105D has already earned the title of the "world's first electronic plane," because its integrated complex of electronic systems permits it to be almost fully autonomous. Flight control, navigation, target seeking, identification and tracking, fire control for defense weapons are all automatically controlled.

With the addition of a night/visual reconnaissance system the F-105D becomes a flexible electronic platform. System design and analysis of the new reconnaissance package and its associated platforms. System design and analysis of the new reconnaissance package and its associated platforms. System design and analysis of the new reconnaissance package and its associated platforms.

### SENIOR & INTERMEDIATE POSITIONS NOW OPEN TO (ENGINEERS (EE) AND PHYSICISTS, TO PERFORM SYSTEMS DESIGN, ANALYSIS, TEST AND RELIABILITY ENGINEERING ON:

Radiars (Front & side looking)  
Infrared Systems  
Acoustics, Radiations  
Data Links

Aerospace Ground Support Equipment

Digital Computers  
Flight & Fire Control Systems  
High Speed Tape Recorders  
Optical Systems

These opportunities are at 2 Republic locations: Mineola and Farmingdale, Long Island. For further information, write us confidentially:

Mr. George B. Wickham  
Technical Employment Manager  
Dept. 10-3  
Republic Aviation Corporation  
Farmingdale, Long Island, New York

Mr. Paul Hartman  
Technical Employment, Dept. 10-3A  
MIL Systems Division  
Republic Aviation Corporation  
223 Jericho Turnpike  
Mineola, Long Island, N. Y.

All qualified applicants will receive consideration for employment without regard to race, color, sex or national origin.



An exciting opportunity is available for the new Post-Master Research & Development Engineer in our new Research & Development Department. The position involves the design and development of all aspects of electronic technology.

**REPUBLIC**  
AVIATION CORPORATION

# VSTOL

**Aerodynamicist • Engineer with interest in dynamics, vibrations and aerelasticity • Performance Engineer for evaluation of VSTOL systems...**

These positions offer both challenge and reward to men interested in analytical and experimental research studies on helicopters and other VSTOL aircraft. Work will be relatively varied and will include preliminary evaluations of novel configurations, as well as long-range research studies on the mechanics of flight at low speeds.

Corporate success and with strong management backing, this program offers both personal security and advancement opportunities to individuals who wish to advance their careers in a complex of modern work facilities, a variety of major and popular test equipment, and the nation's largest industrial computational laboratory. Publication of papers is encouraged.

Since experience in this program requires that we fill these positions immediately, write today to Mr. W. D. Walsh, Personnel Dept.

All qualified applicants will receive consideration for employment without regard to race, color, sex or national origin.

**RESEARCH LABORATORIES**  
**UNITED AIRCRAFT CORPORATION**

400 Main Street, East Farmingdale, N. Y.







NOW...on the new LOCKHEED JetStar...

16 ESNA® **DP**\* NUTS APPLIED

...give unparalleled reliability

TO NAS630 ENGINE MOUNT BOLTS

to critical power plant attachments



When you specify a high-tensile fatigue qualified bolt for a high-stress application, it's usually because you want to insure a reliable connection. But, if just any ordinary high-tensile nut is applied to that bolt, its reliability under dynamic loading may be reduced. It may perform no better than an ordinary bolt, despite the price paid for greater reliability.

The stress photos here show why. In an ordinary locknut the load is concentrated on the lower three threads of the nut. This load concentration can accelerate bolt fatigue—and possible failure. But with an ESNA Double/Durability\* nut—featuring the revolutionary EQUA-STRESS thread pattern—the stress load is re-distributed over *all* the threads. The reliability of the bolt is safe-



OLD



NEW

guarded because the bolt is more uniformly loaded and the unit load per thread is reduced!

Lockheed engineers design for reliability, and tests confirmed ESNA data showing that Double/Durability nuts could be depended upon to increase the fatigue life of the JetStar power plant attachments.

Double/Durability nuts can provide the kind of reliability insurance you want for your critical bolted connections. In fact, they actually multiply the fatigue endurance of high-tensile bolts from 2 to 30 times! Write for Design Manual

5930—with complete photo-elastic studies and data. Dept. S61-725, Elastic Stop Nut Corporation of America, 2330 Vauxhall Road, Union, N. J.



LH3393T, (220,000 psi)  
LHEB220T, (220,000 psi)



LH2577T, (180,000 psi)  
LH3220T, (220,000 psi)



EBT, (180,000 psi)



LH3489T, (180,000 psi)